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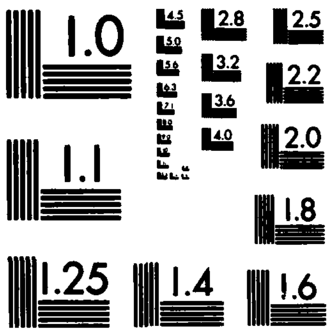

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CHARACTERIZATION OF SELECTED VOLATILE ORGANICS IN WASTEWATER TREATMENT INFLUENTS

A Thesis submitted to the

Division of Graduate Studies
of the University of Cincinnati

in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE

in the Department of Environmental Health
of the College of Medicine

1983

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by

Victoria S. Dunovant

B.A. Chemistry/Biology, West Virginia University, 1974

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INTRODUCTION

Municipal wastewater treatment facilities handle a variety of combinations of industrial, commercial and residential wastes, all of which contain complex mixtures of volatile organic compounds. Many of these volatiles are known to pose a potential health risk to personnel working in the sewers or in the wastewater treatment plant itself. Recent surveys by the National Institute for Occupational Safety and Health (NIOSH) of a wastewater collection system have detected dangerous concentrations of vapors in some of the sewer airspaces (13,14). However, the complex mixtures, the variable nature of the wastewater and the multiplicity of confounding factors complicates the measurement and assessment of the potential risks.

Various approaches have been proposed to assess the concentrations of organic chemicals in sewer airspaces such as the measurement of individual compounds in the air, the use of direct reading organic vapor detectors and the prediction of maximum possible air concentrations based on wastewater data. Little information is available on the composition and variability of the air concentrations in airspaces above wastewater.

An opportunity to address some of these issues was available by conducting air and water quality monitoring where incoming wastewater enters each of the three largest wastewater treatment plants of the Metropolitan Sewer District of Greater Cincinnati, Ohio (MSD). These influent areas are located in structures that extend below the surface of the ground to coincide with the location of incoming wastewater, are enclosed, and are locations frequented routinely by workers. Another

factor making these plants suitable for study was that each received a different proportion of industrial waste and varied by more than an order of magnitude with respect to their size.

The objectives of this study were as follows:

1) Characterize and compare the variability in air and water concentrations both within and between each of the influent areas of the three different wastewater plants in Cincinnati, Ohio.

2) Compare analytical determinations for specific compounds to total organic vapor concentrations determined by direct reading instruments.

3) Determine the correlation between vapor and water concentrations of total organics and individual compounds.

4) Evaluate and compare four different schemes for assessing the risk from exposure to vapor concentrations in wastewater facilities.

The individual compounds for which analyses were performed were the U.S. Environmental Protection Agency (EPA) volatile organic priority pollutants (15). Water concentrations for both halocarbons and aromatics were determined by EPA methods 601 and 602 (40 CFR Part 136) (25,26).

BACKGROUND

Industries in the United States discharge over 1 trillion gallons of wastewater, most of which is untreated, to public sewers each year. Other chemical discharges occur from commercial and residential sewer users. The content and concentrations of these discharges varies dramatically from one plant to another and from one hour to the next.

Until the past four or five years, there was almost no existing information regarding health hazards posed to personnel working in wastewater treatment plants and sewer airspaces due to exposure to organic chemicals. The primary reason for this lack of information resided in the fact that identification and quantification of trace amounts of organic chemicals was beyond the scope of existing analytical instrumentation and techniques and because of the enormous number of possible sampling locations. As analytical instrumentation and techniques became more sophisticated and more available for practical use, interest increased regarding wastewater contents and concentrations primarily from the point-of-view of the plants' effluents into nearby bodies of water (rivers and lakes). Initially wastewaters were analyzed for specific classes of compounds such as polynuclear aromatic hydrocarbons (Reichert, et al., 1971) (2) and polychlorinated biphenyls-PCB's (Schmidt, et al., 1971) (3) and (Lawrence, et al., 1976) (4). In 1976, in response to complaints concerning the enforcement of the Clean Water Act, the Environmental Protection Agency issued a list of 127 priority pollutants (5). At about the same time Glaze, et al., 1976 (6) and Chian and DeWalle, 1983 (7) identified a wide range of compounds in wastewater effluents. Shortly

thereafter, the U.S. EPA (and their contractors) also published several studies of toxic chemicals present in wastewaters (Cohen, et al., 1981 (1), Pelizzari, 1981 (8), Kyosai, et al., 1981 (10), Petrasek, et al., 1981 (11)).

However, the aforementioned studies concentrated on characterizing the wastewaters without regard for the potential to adversely affect the workers in these wastewater treatment plants. In 1980 and 1981 the National Institute for Occupational Safety and Health (NIOSH) performed two Health Hazard Evaluations (HHE), one in response to workers at a collapsed sewer in Cincinnati (12) and the other a general survey of the sewerage system in Cincinnati (13). In contrast to previous work, NIOSH's study focused on worker exposures to chemicals present in the wastewater and surrounding airspaces. NIOSH concluded that the potential for a health hazard did exist and that appropriate corrective and protective measures should be taken.

In this same time frame, Toogood and Hobson, 1980 (14) at the Water Research Centre in Great Britain published a method for "Determination of Safe Limits for the Discharge of Volatile Materials to Sewers." This study proposed a method by which the maximum air concentrations could be predicted from the wastewater concentrations by assuming equilibrium concentrations in aqueous and vapor phases.

Lurker, 1982, 1983 (15,37) looked at the volatilization of organic compounds from the activated sludge process within a sewage treatment plant receiving pesticide wastes. Decker, 1980 (16) and Staley (17) studied the fugitive emissions from a toxic waste incinerator; the former

was concerned with worker exposure and the latter with general environmental contamination.

However, until quite recently very little actual measurement of the variability of air concentrations of airspaces in sewers and wastewater treatment facilities had been undertaken. In 1983, Barsky (18) performed a study comparing three direct reading instruments in the presence of high humidity and then further tested these instruments in several sewer locations and at the influent (wet well area) of a wastewater treatment plant in Cincinnati. Barsky's study (18) coupled with NIOSH's studies (12,13) and Toogood and Hobson's proposal (14) formed the basis for formulating the objectives of this thesis. In addition, a study performed by Black and Veatch (19) for the Metropolitan Sewer District (MSD) of Greater Cincinnati provided an indication of some of the compounds present in the wastewater and their variability at two of the plants in this study. The third plant had previously been monitored under an EPA-sponsored effort (37).

PLANT DESCRIPTIONS

The three plants involved in this study are all located in the Cincinnati area and are operated by the Metropolitan Sewer District of Greater Cincinnati (MSD) for the Hamilton County Commissioners. A map of the MSD service areas is presented in Figure 1 and shows the location of each of the following wastewater treatment plants:

1) Mill Creek Plant
2) Muddy Creek Plant
3) Little Miami Plant

This study concentrates on the initial influent area of each plant which is located immediately after the distribution chamber that receives all incoming raw wastewater flow from the sewerage system. From the distribution chamber, the wastewater enters the bar screen or bar rack. The bar screen removes large foreign objects from the wastewater in order to protect the pumps. From the bar screen, the wastewater flows into the wet well where the wastewater is pumped from the wet well to an elevation that will permit gravity flow throughout the rest of the treatment process. All air and water sampling was conducted immediately adjacent to the bar screen area, after the diversion chamber and before the wastewater enters the wet well/pump area.

Mill Creek Treatment Plant

The Mill Creek Plant is one of the largest wastewater treatment plants operated by MSD and it services the highly industrialized Mill Creek Valley (Figure 1). It has a service area of approximately 133 square miles and serves over a half million persons. The Mill Creek Plant is designed to

handle a dry weather flow of 120 million gallons per day (MGD) and has facilities to handle a maximum of 360 MGD of combined wastewater and storm flow.

Figure 2 shows the four Mill Creek interceptors that feed into and mix in the diversion chamber which then forms the combined flows which enter the bar screen and wet well. Figure 3 is a diagram of the screen building which houses two parallel protective screening devices. The material caught on the bars of the screening devices is removed by traveling rakes and deposited in large containers for disposal.

The Mill Creek Plant bar screen area is ventilated using forced air ventilation as opposed to exhaust ventilation in an attempt to shift the liquid-air equilibrium backwards in favor of the liquid phase. Air ducts about 12 inches in diameter bring air from the roof of the bar screen building. The ducts extend down to about 2 meters above the working floor just above the incoming wastewater. This ventilation provides between 5 and 10 room air changes per hour.

In addition to raw wastewater entering the plant, some return flow from the plant was also being recycled into the interceptors from the sludge digestor ("heavy" supernatant) and the thermally conditioned sludge thickener (from the ZIMPRO process). The magnitude of these return flows range between 0 and 10 MGD.

Muddy Creek Treatment Plant

The Muddy Creek Plant provides wastewater treatment from the largely residential areas in western Hamilton County (Figure 1). This plant services approximately 22 square miles and is designed to handle a dry

weather flow of 15 MGD.

The Muddy Creek Plant has two interceptors which feed into the diversion chamber: the East Branch Muddy Creek Interceptor and the West Branch Muddy Creek Interceptor. This plant has a stationary bar screen which must be cleaned/raked by hand. The bar screen area is also totally open to the upper floors of the pump building. The bar screen is ventilated only by general building ventilation. However, due to the low capacity and primarily residential wastewater the risk to employees is lower than at a larger or more industrialized plant.

Little Miami Treatment Plant

The Little Miami Plant is the second largest wastewater treatment plant operated by MSD and services approximately 86 square miles in eastern Hamilton County (Figure 1). The Little Miami Plant is designed to handle a dry weather flow of 38 MGD and has facilities for handling a maximum of 98 MGD of combined wastewater and storm flow.

The Little Miami Plant has one primary interceptor which flows into three interconnected collection and flood control chambers before entering either of the two pump buildings. The newer pump building normally handles the majority of the wastewater flow and is similar in design to that of the Mill Creek Plant. It has automated bar screen rakes and is essentially separated from the rest of the building. The Little Miami Plant also uses forced air ventilation similar to that at the Mill Creek Plant.

SAMPLING METHODS

Sampling and Analysis Plan

This study involved two separate aspects: field surveys of the influent (wet well) area with direct reading instruments and simultaneous collection of water and air samples for laboratory analysis. The field studies were designed to evaluate the two different direct reading instruments: the portable Century Organic Vapor Analyzer (OVA) equipped with a flame ionization detector (FID) and the portable H-NU equipped with a photoionization detector (PID-11.7 eV). Both instruments measure total hydrocarbons in parts per million (PPM), but are responsive to different compounds with varying sensitivities. The water and air samples for laboratory analysis were collected to determine actual concentrations of individual compounds present in both the water and the air. These concentrations were then correlated with total levels determined on the direct reading instruments. The concentrations found in the water were also correlated with the concentrations in the air. This study was also designed to characterize both the influent quality and the resultant atmospheric quality at three different waste treatment plants within the MSD. The variability within each plant was monitored hourly and daily and the three plants were compared to each other with respect to their variability. Air and water data were also applied to four basic methods of assessing personnel exposure to volatile organic chemicals: 1) predictions from water concentrations, 2) air sampling for specific compounds, 3) direct reading instruments to determine total volatiles, and 4) determination of vapor head space analysis.

Sampling

Samples were collected on seven consecutive days at three different sewage treatment plants for 8-12 hours each day. The three plants studied were all part of the MSD and were as follows:

1) Mill Creek Sewage Treatment Plant
2) Muddy Creek Sewage Treatment Plant
3) Little Miami Sewage Treatment Plant

The sampling was conducted in the wet well/bar screen area which is the initial point where the combined industrial, domestic and commercial wastewater flow enters the sewage treatment plants. The sampling was conducted between 9 August 1982 and 6 September 1982.

Three direct reading instruments were used: 1) a Century Organic Vapor Analyzer (OVA) with a flame ionization detector (FID), 2) a H-NU photoionization detector (PID) equipped with an 11.7 eV lamp, and 3) a Biomarine Combustible Gas Meter which determined percent oxygen, percent LEL as hexane (lower explosive limit) and percent methane. These three instruments were operated continuously and monitored visually. Readings were recorded every 30 minutes and whenever there was a marked change in readings.

Charcoal tube samples were collected according to three different criteria. Eight hour time weighted average (TWA) samples were collected for each sampling day at a flow rate between 0.014-0.018 liters per minute (LPM). Charcoal tube samples were also collected each time there was a marked increase ("peak") in either of the direct reading instruments (OVA and/or H-NU). These "peak" samples were collected at a flow rate of 1.85 LPM for the duration of the peak unless the "peak" lasted longer than 30

minutes, in which case a second charcoal tube was utilized. At Mill Creek (the largest plant), a peak was defined as a reading equal to or greater than 100 PPM. At the other two plants a peak was defined as a reading equal to or greater than 50 PPM. In addition, charcoal tubes were collected at other points of interest such as the outside grate at Mill Creek and the area behind the bar screen at Little Miami. These "special" samples were collected at a flow rate of 0.92 LPM for approximately 60 minutes.

Water samples were also collected to correspond with the "peak" readings. These water samples were instantaneous grab samples which were collected in duplicate according to EPA guidelines (40CFR, Part 136, December 1979, Methods 601, 602 and 624) (5,25,26).

Additional meteorologic, wastewater and plant operating condition information was also collected to aid in the evaluation of the results: 1) wet bulb temperature, 2) dry bulb temperature, 3) humidity, 4) water temperature, 5) pH of water, 6) water flow into the plant in million gallons per day (MGD), 7) direction and extent of ventilation, 8) outside weather conditions (rain), temperature, and 9) characteristics of wastewater such as color, smell and the presence of detergent. The above mentioned data was collected every 30 minutes to coincide with the direct reading instrument data. Hereafter, this information will be be referred to as sampling condition data.

The samples (water and charcoal) were collected and kept on ice until time of analysis. The samples were analyzed by standard methods using the facilities at the Occupational Environmental Health Lab (OEHL), Brooks Air Force Base, Texas. The analytical results of the analyses were evaluated

using the University of Cincinnati Statistical Analysis System (SAS-796).

The results of this sampling strategy were examined with respect to four different methods of assessing personnel exposure. The results were first examined by individual compounds present. The total of these individual compounds were then compared to the direct reading instrument data. Next the results from the water analyses were examined in comparison to Toogood and Hobson's (14) proposal that predicts the maximum allowable water concentration which will allow the air concentrations to remain below the TLV's. Finally, the water data was examined with respect to the following proposal by MSD:

> Gentlemen:
>
> The MSD intends to make the following change in your Wastewater Discharge Permit effective May 15, 1982.
>
> > By no later than August 15, 1982, the total concentration of organic material in Permittee's wastewater shall not exceed that amount which causes a concentration of 300 parts per million (v/v) of organic substance in the vapor space above a grab sample of Permittee's wastewater equilibrated at 20°C in a closed vessle whose volume is twice that of the wastewater sample.

The MSD proposal which determines vapor headspace above the wastewater at equilibrium was compared to the water analyses data that was analyzed by the Purge and Trap method. This comparison is limited by the fact that the MSD proposal represented equilibrium concentrations while the Purge and Trap Method represented total concentrations forced out of the wastewater.

ANALYTICAL METHODS

Instruments

The two direct reading instruments were chosen to complement each other with respect to the compounds that they would detect and also because of their portability and safety in potentially explosive atmospheres such as those likely to be encountered in sewage treatment plant influent areas.

Century Systems' Portable Organic Vapor Analyzer (OVA)

The Century Model OVA-128 is designed to measure trace quantities of organic vapors and gases. It is incapable of causing ignition of hazardous atmospheric mixtures and can measure concentrations ranging from 1 to 1,000 ppm. The OVA is a lightweight, portable unit which can be operated on batteries or by alternating electrical current. This instrument functions as a flame ionization detector (FID). Like conventional gas chromatographs, the OVA must be calibrated with a known compound and concentration. A continuous sample is drawn into the probe, metered, filtered and transmitted to the FID. Inside the FID, a hydrogen flame ionizes (burns) the organic vapors. The resultant positively charged ions are collected at a negative collecting electrode with the aid of the electric field between the conductors and the collecting electrode. As the carbon-containing, positive ions are collected, a current is generated in relation to the rate of collection. This current is amplified and converted to an output signal which can be read on the meter or the recorder in ppm's based on the calibration compound (20).

The OVA-FID is highly sensitive to hydrocarbons (saturated, un-

saturated and aromatic) such as hexane, methane, benzene and toluene and similarly sensitive to mono-substituted halogenated compounds. The FID is less sensitive to polysubstituted halogenated compound and compounds with a low ratio of carbon-oxygen, carbon-nitrogen or carbon- sulfur atoms. For detection with the FID, a compound must have both carbon and hydrogen in its' makeup. Therefore, it has only a negligible response to carbon monoxide (CO), carbon dioxide (CO_2), ammonia (NH_4), sulfur dioxide (SO_2), hydrogen sulfide (H_2S), carbon disulfide (CS_2) and water (H_2O) (20).

For this study the OVA was calibrated based on toluene (10, 100, 500 PPM) in the presence of approximately 90% humidity using the same equipment and method described by Barsky (18). Relative sensitivites of the OVA to various compounds are listed in Table 1. These sensitivities are listed using toluene (the calibration standard) as 100% and reflect sensitivities in dry air (20) and experimental values in 90% humidity. The sensitivity was not significantly altered due to the high humidity since the calibration compound (toluene) was prepared in the presence of 90% humidity.

H-NU Systems Photoionization Detector

The H-NU Model PI 101 is a photoionization detector designed to measure trace concentrations of gases and vapors. The H-NU can be equipped with several different lamps or sensors depending on the ionization potentials of the compounds to be detected and the possible interferences. The sensor is a sealed ultraviolet light source that emits photons energetic enough to ionize many compounds. The ionized compound is driven (by an electrical field) to the collector electrode where the resultant

current is measured.

The lamp used for this study is the 11.7 eV lamp. This lamp responds to any gas or vapor with an ionization potential less than or equal to 11.7. However it will not respond to compounds with ionization potentials greater than 11.7 such as O_2, N_2, CO, CO_2, H_2O, CH_4, H_2 or SO_2. Unlike the OVA-FID the H-NU-PID will detect ammonia and hydrogen sulfide but not methane.

In this study, the H-NU PID was also calibrated using toluene (10,100 and 500 PPM) in the presence of approximately 90% humidity. The H-NU calibrated and functioned properly in the laboratory. However, in the field the instrument's response deteriorated rapidly. After several hours, the H-NU no longer responded to even the calibration gas. After solvent cleaning of the lamp, the instrument would respond but with a marked decrease in sensitivity. A new lamp was obtained from the manufacturer; however, the result was identical (See Figure 4). For this reason further use of the H-NU was discontinued. The 11.7 lamp has a decreased sensitivity in the presence of high humidity (18). This disadvantage in itself could be compensated. However, in the presence of a mixture of water vapor and corrosive gases (SO_2, NO_2, H_2S) the lamp did not function properly. The 10.2 eV lamp may have operated properly, however, it would not have detected ammonia or hydrogen sulfide and the 10.2 eV lamp is also somewhat erratic in the presence of high humidity (18).

With the use of the H-NU coupled with the OVA, it may have been possible to estimate the percent contribution of methane, hydrogen sulfide and ammonia. However, because of the unreliability of the H-NU (11.7 lamp)

in the presence of high humidity combined with a corrosive atmosphere, this portion of the study was abandoned.

Biomarine Combustible Gas Meter

A Biomarine Combustible Gas Meter was also used in this study primarily as a safety precaution. This direct reading instrument determines % oxygen, % LEL hexane (lower explosive level), and % methane. This instrument was also equipped with an audible alarm. During the three weeks of sampling the instrument consistently gave the following readings: 21% O_2, $\leq$2% LEL hexane and $\leq$0.1% methane.

ANALYTICAL METHODS

Laboratory Analysis

Overview

All samples were maintained on ice following collection, during shipment and upon receipt at the U.S. Air Force Occupational and Environmental Health Lab (OEHL), Brooks AFB, Texas. The charcoal tubes were analyzed using standard NIOSH methods which involved desorption in carbon disulfide and subsequent analysis by gas chromatography using a flame ionization detector (FID). The duplicate water samples were split into two sets. The first set was analyzed for purgeable halocarbons using standard EPA method 601 (40 CFR Part 136) (25,26). The purgable halocarbon method employed a purge and trap gas chromatographic set up equipped with a Hall Electrolytic Conductivity Detector (HECD). The second set of water samples was analyzed for purgeable aromatics using standard EPA method 602 (40 CFR Part 136) (25,26). This method also made use of a purge and trap set up; however, the detector required was a photoionization detector (PID). All of the samples were integrated into the OEHL quality control program in order to verify the accuracy of the analytical results.

Analysis of Charcoal Tube Samples

Analysis of the charcoal tubes was accomplished according to standard NIOSH procedures. The front and back sections of the charcoal tube were removed separately and desorbed in 1 milliliter of Baker Analyzed Reagent Grade carbon disulfide, vortexed and allowed to desorb for at least one hour. At this time the carbon disulfide mixtures

containing the desorbed compounds were transferred to two-milliliter auto sampler vials. The samples were then analyzed automatically by flame ionization (FID) gas chromatography (GC). Appropriate standards were selected in response to the compounds found to be present in the water as well as other compounds suspected to be present. Standards were run both individually and as mixtures in order to determine retention times, concentrations and possible interferences. Each sample was run first on the 10 ft. 10% FFAP column as a screen and then rerun on one or more of the three columns for verification and additional peak separation. The chromatographic instrument parameters are listed on Table 2, detection limits in Table 3 and the computer method and sequences employed in the analytical procedure are presented in Appendix 1. In general, the computer method automates the analysis, by controlling the run time, syringe washes, sequence of injections, and the method of peak integration.

Purge and Trap Methods (EPA 601/602) for Analysis of Water Samples

In the Purge and Trap Methods, an inert gas is bubbled through a five ml. water sample contained in a specially-designed purging chamber at ambient temperature. The halocarbons/aromatics are efficiently purged from the aqueous phase to the vapor phase. The vapor is passed through a sorbent trap where the halocarbons/aromatics are trapped. After purging is completed, the trap is heated and backflushed with the inert gas to desorb the halocarbons/aromatics onto a gas chromatographic column. The gas chromatograph is temperature programmed to separate the halocarbons/aromatics which are then detected with an electrolytic conductivity detector/photoionization detector. The identification and

quantification of the individual compounds is confirmed using a second dissimilar gas chromatographic column.

External standards were utilized both individually and as mixtures. These standards were prepared according to standard EPA methods 601 and 602. Individual stock standards were prepared by weight in methanol (mg/L) and then sequentially diluted to the low pg/L levels in methanol. Mixtures were also prepared from the first stock standard and diluted as above. Each standard sample (individual or mixture) for the GC was prepared by taking one ml. of the desired stock concentration and adding it to 99 mls. (in a volumetric flask) of organic free water. This flask was capped and mixed and ten mls. were withdrawn for analysis.

The specific purge, trap, and GC parameters that were used are listed in Table 4 for purgeable halocarbons and Table 5 for purgeable aromatics. The compounds analyzed, their retention times and detection limits are presented in Table 6 and 7, respectively for purgeable halocarbons and aromatics. The computer methods and sequences employed in the analytical procedures for halocarbons/aromatics are presented in Appendices 2 and 3, respectively.

Calculation of Concentrations of Specific Substances of Water

The individual halocarbon/aromatic compound concentrations were calculated as follows:

$$\frac{\text{Sample area}}{\text{Standard area}} \times \text{Standard Concentration } \mu g/l = \mu g/l \text{ (= PBB)}$$

The individual concentrations were summed to achieve a total halocarbon (WTCUGL), a total aromatic (WTAUGL) and a combined total (WTAC). For the aromatics, the total area under all peaks was calculated as if they were

all toluene (WZAUGL) in order to relate the water concentrations to the direct reading instruments (OVA) which were calibrated based on toluene. In addition, calculations were made for total aromatics and total aromatics expressed as toluene excluding 1,2,4-trichlorobenzene (WTABZ and WZABZ, respectively). 1,2,4-Trichlorobenzene was determined in this study because it was known to be present in high concentrations particularly at the Mill Creek Sewage Treatment Plant. The suggested methods of analysis for 1,2,4-trichlorobenzene are EPA method 612 or 625 which involve different collection and analysis methods from the ones used in this study. These methods involve solvent extraction and concentration of a one-liter sample, followed by florisil cleanup when analyzing complex wastewaters. In contrast, this project only involved collections of 20 ml. samples for purgeables. However, EPA has documented 1,2,4-trichlorobenzene using the aromatic EPA method 602 which was used in this study. The standards for 1,2,4-trichlorobenzene were readily identifiable, however the recoveries were only between 60-70%. This compound eluted from the gas chromatograph at approximately 31.3 minutes and in the wastewater samples appeared as a broad two-fold peak on both columns which indicated an interference and made the quantitation suspect. For this reason, the TCBZ results were only an indication of the presence and general magnitude of TCBZ and not an analytically accurate concentration. The raw analytical results are presented in the next section.

Calculation of Concentrations of Specific Substances in Air

The individual compounds identified from charcoal tube samples were calculated as follows:

$$\frac{\text{Sample area}}{\text{Standard area}} \times \text{Specific Gravity} \times \frac{1000\ \text{l}}{\text{m}^3} \times \text{Vol (liters)} = \text{mg/m}^3$$

These individual concentrations were also calculated in parts per million (PPM).

The concentrations for individual substances in charcoal tube air samples were summed to achieve totals (CTMGM and CTPPM) expressed in mg/m^3 and PPM, respectively.

In addition the total chromatographic area was calculated based on toluene (CZMGM and CZPPM) in order to compare the charcoal tube concentrations to those of the direct reading instruments. This calculation was made both for the total identifiable compounds and for the entire chromatographic area (which included unidentifiable peaks).

STATISTICAL METHODS

Various statistical procedures were performed on the raw data at the University of Cincinnati Computer Center using the Statistical Analysis System (SAS-796) (31). The raw data was keyed into a WYLBUR (32) system and then transferred to a University of Cincinnati data base (M80116) for accessing by SAS-796. The SAS-796 statistical programs are briefly described below and presented in detail in Appendix 4.

SASRUN 1 - This program transferred all raw data from WYLBUR to the main data base in the proper format for SAS manipulations.

SASRUN2 - This program performed Pearson correlations between Century (PPM) values and selected water and air values. Regression analysis was also performed on the Century (PPM) values with respect to the three different plants.

SASRUN 3 - This program performed Analysis of Variance (ANOVA) and General Linear Model (GLM) on the PPM values with respect to the different plants. This program also performed additional Pearson Correlations and plotted the various variables with respect to PPM values.

SASRUN 4 - This program performed additional Regression Analyses comparing total values for water and air as well as the Century PPM values and plotted the respective variables.

SASRUN 6 - This program plotted an overlay of PPM values vs. flow by plant and perfomed Pearson Correlations by individual plants on all other variables (air and water).

SASRUN 7 - This program performed three types of correlations (Pearson, Spearman and Kendall) by plant on all water and air variables,

including the sampling condition information (see page 11).

SASRUN 8 - This program performed a one way nonparametric analysis by plant on selected charcoal tube values. A GLM was also run comparing different times of the day and different days for each plant. A second GLM was run comparing weekday to weekend for each plant. Various values were also plotted to investigate additional relationships.

RESULTS

Variability and Sampling Conditions Data

Tables 8.1-8.3 summarized the numbers and types of samples collected at each of the three plants. The variation in sampling conditions and the Century OVA data is presented in Tables 9.0-9.3. Table 9.1 presents the data for the Mill Creek Wastewater Treatment Plant; Table 9.2 presents the data for the Muddy Creek Plant; and Table 9.3 presents the data for the Little Miami Plant. The key for the computer generated tables (9.1-9.3) is presented in Table 9.0. Each of the parameters in these tables was recorded every 30 minutes. The Century OVA data are presented in both PPM and mg/m^3. The data in Tables 9.0-9.3 are also graphicly displayed in Figures 5-7, by plant. The above mentioned tables and figures represent total hydrocarbon concentrations based on toluene as the calibration standard for the Century OVA and demonstrate the wide fluctuation in concentrations hourly within a single plant and between the three different plants.

Hourly and daily variation in both total hydrocarbon (Century OVA) values and the water and air concentrations was the most dramatic at the Mill Creek Plant which was also the largest wastewater treatment plant in this study. At the Mill Creek Plant the concentration of total hydrocarbons was generally greater in the afternoon than in the morning (except Monday) and was generally higher on weekends than during the week. However, these data only represent one week's sampling and are not necessarily representative of other weeks or other seasons. The values were not statistically different from one hour to the next. However, if

the data were broken into only two time periods (0900-1400 and 1400-1900) then there were a larger number of peaks during the afternoon hours at each of the three plants (see Table 26 and Appendix 5).

At the Muddy Creek Plant the total hydrocarbon values were also generally greater in the afternoon than in the morning. It was also noticed that the concentrations increased in response to rainfall.

The Little Miami Plant also showed the same trend as the other two plants in that the afternoon concentrations were greater than the morning. However, at the Little Miami Plant the concentrations tended to decrease with rainfall.

Table 10 shows the Pearson Correlations for sampling conditions data correlated with the Century OVA data (PPM) for each of the three plants. Several of these correlations were statistically significant at or below the 0.001 level; however the correlation coefficients were relatively low (between -0.30112 and +0.56456) which indicates that no single factor could consistently be used to predict the presence of peaks on the Century OVA.

At the Mill Creek Plant the Century readings were highest (according to correlation coefficients) when the flow was low, late in the day, late in the week (weekends) and when the air and water temperatures were high. The Muddy Creek Plant readings were highest late in the day, when the water was colored, when the water temperature was high, when the air temperature was lower and when the humidity was high. In contrast, the Little Miami Plant readings were highest when the flow was low, late in the day, late in the week, in the absence of rainfall and when the water

and air temperatures were lower. All of these observations are based on correlation coefficients with $P<0.01$.

Charcoal Tube Sample Analyses

Tables 11.1-11.3 present the results of the analysis of charcoal tube air samples collected during periods of peak episodes observed on the Century OVA for the respective plants. At the Mill Creek Plant a peak was defined as any Century OVA value greater than 100 PPM. Whereas, at the other two plants a peak was defined as any value greater than 50 PPM since the baseline values were much lower than the Mill Creek Plant. Table 12 shows the results of the analysis of the 8 hour TWA charcoal tube samples for the respective plants and Table 13 presents the results of the analysis of charcoal tube samples collected at other sites of interest. The samples collected at these other sites include samples collected above the airspace of the venting grate at the Mill Creek Plant where the main sewer lines are combined prior to entering the wet well/bar screen area. This venting grate was installed as an added safety precaution to provide the volatile compounds being mixed an outlet prior to the wastewaters' entry to the wet well. Other samples were taken only six inches above water level rather than in the breathing zone area and samples taken above pools of water in the wet well but behind the bar screen at the Little Miami Plant where the building was open in the center for three floors. Pearson Correlations are shown in Table 14 correlating the Century OVA data (PPM) with results of the charcoal tube sample analyses. Only three correlations were statistically significant at or below the 0.001 level. These three correlations were all found at the

Mill Creek Plant and concerned the following compounds correlated with the Century OVA (PPM) data: MIBK, chlorobenzene and toluene. MIBK and chlorobenzene were only detected in about 10% of the samples, however when they were present the Century values were high. Toluene on the other hand was present in almost all of the samples and when the Century values increased so did the toluene concentrations found in the charcoal tube samples. Benzene also had a relatively high correlation coefficient at the Mill Creek Plant. Table 15 presents three different types of correlation coefficients (Pearson, Spearman and Kendall) comparing Century OVA data (PPM) with the charcoal tube sample results for the Mill Creek Plant. The Spearman and Kendall correlation coefficients are nonparametric correlations; however they show the same trends as the Pearson Correlations but with higher confidence levels (greater than 0.001).

Water Sample Analyses

The results of the water analysis are presented in Tables 16 and 17. Table 16.1-16.3 gives the results of analyses for chlorinated organic compounds (halocarbons) for the three respective plants with a key of abbreviations in Table 16.0. The results of the analyses for aromatic compounds are presented in Tables 17.1-17.3 with Table 17.0 as the key. Table 18 presents Pearson Correlations comparing Century OVA data with the results of selected water sample analyses. The results of the water analyses did not correlate with the Century data. The confidence levels were never below 0.1245 and many of the correlation coefficients were slightly negative values.

Comparison Studies of Water and Air Samples

Tables 19.1-19.3 presents the Century OVA data (PPM) and the total concentrations found on the charcoal tubes (in PPM and PPM based on toluene) and also compares the water concentrations as total chlorinated, total aromatic, sum of chlorinated and aromatic and a total aromatic based on toluene (all expressed in μg/l - PBB).

Tables 20.1-20.3 presents statistical summaries of water and air concentrations by compound: range, mean, median and frequency of detection (%). Table 20.0 presents a key for Tables 20.1-20.3.

Table 21.1-21.3 compares selected charcoal tube samples to their respective Century OVA values, both expressed in PPM. The first column gives the total of the individual compounds found on the charcoal tubes. The second column expresses this total as if all the compounds were toluene. The third column expresses the total area of the chromatogram as if it were toluene. This third column includes small unidentified peaks in addition to the compounds identified. The fourth column represents the Century OVA values recorded at the time the charcoal tube samples were collected. The Centruy OVA values are expressed as PPM toluene since the instrument was calibrated based on toluene. Even when the total concentrations on the charcoal tubes are expressed as toluene, the charcoal tube samples represent less than 20% of the Century OVA readings.

Table 22 lists the ACGIH TLV's and STEL's for the compounds in this study. These values are also listed in Table 23 along with pe[illegible]nent values needed to calculate the $C_{TLV's}$ and RAT's presented in Toogood and Hobson's paper (14). The C_{TLV} represents the maximum allowable con-

centration in water for a single compound so that the TLV in air will not be exceeded. This value is calculated using the TLV, vapor pressure (VPo), the limiting activity coefficient including sewage at the appropriate temperature (γ_∞) and the molecular weight in the following formula:

$$C_{TLV} = \frac{TLV}{VPo} \times \frac{MW}{\gamma_\infty} \times \frac{760}{18\ (MW\ H_2O)}$$

Toogood and Hobson's (14) C_{TLV}'s are derived based on a static equilibrium assuming no ventilation of the sewer airspaces. The RAT refers to the relative atmospheric toxicity which is calculated by the following formula:

$$RAT = \frac{Ci}{C_{TLV,\ i}}$$

Table 24 presents the C_{TLV}'s for the compounds detected at the three plants as well as the maximum % of the C_{TLV} detected and the range of the concentrations found. Table 24 also shows that only at the Mill Creek Plant did the concentrations exceed 5% (but less than 10%) of the RAT proposed by Toogood and Hobson (14).

Table 25 presents a summary of the statistics that were performed comparing air and water quality data in addition to the correlation coefficients. In all of these tests the results were not statistically significant.

Table 26 gives a summary of the number and magnitude of the peaks observed on the Century OVA, which were compared statistically. Table 26 shows there is definitely a greater number of peaks in the afternoon as opposed to the morning at each of the three plants. The statistics for

Table 26 are presented in Appendix 5 where a log linear model is developed which is based on the data in Table 26. The best fitting model is as follows:

$$\log P_{\text{Plant-time-peak}} = U_{\text{Plant}} + U_{\text{Time}} + U_{\text{Peak}} + U_{\text{Plant-Peak}} + U_{\text{Time-Peak}}$$

This model indicates that all interactions between plant, time and peak must be considered except the interaction of plant with time.

DISCUSSION

Figures 5-7 graphically displayed the daily plant variation in total hydrocarbon concentrations hourly and daily. The correlation coefficients in Table 10 showed that the hydrocarbon concentrations were generally higher late in the afternoon and on weekends. The higher concentrations were also correlated with lower flows which generally occurred late in the day and on weekends. Table 26 compared the total hydrocarbon concentrations in the morning (0900-1400) with those in the afternoon and evening (1400-1900). The afternoon concentrations were generally higher and much more variable at all three of the plants confirming the results presented in Table 10. The two smaller plants showed a more exaggerated difference between morning and afternoon concentrations than the Mill Creek Plant which is probably more a reflection of the lower flows at the two smaller plants.

The higher afternoon concentrations were probably due to the startup of industrial activity in the mornings and the sewer transit time (time it takes for the wastewater to travel from origin to plant) as well as increased residential use in late morning. The changes noted in association with rainfall could incorporate multiple occurrences. The decreased concentrations at the Little Miami Plant may merely reflect dilution of the wastewater by strom runoff. The increased concentrations at the Muddy Creek Plant appear to represent a case where the storm runoff washes the sewage through the system as a slug since the Muddy Creek Plant is the smallest of the three plants with the least amount of industrial contribution to the sewer system. The possibility

that this increase represents industrial fugitive dumping, though unlikely, cannot be discharged. This increase during rainfall could also represent soil leachate from some of the nearby tank farms.

In comparing the charcoal tube samples with the total hydrocarbon values (Century OVA), it is noteworthy that in almost all cases the charcoal tube sample represented less than 10% of the Century OVA concentrations. Some of this difference may lie in the fact that the Century OVA does detect methane and the very light hydrocarbons (ethane, propane etc.), whereas the charcoal tubes will not collect the permanent gases. It is also possible that the high humidity decreased the adsorption capabilities of the charcoal, however no water was detected condensed within the charcoal tubes. Many other factors (displacement, ventilation, etc.) may have decreased the charcoal tubes adsorption capabilities but none of these factors alone or combined should have altered the results by more than 10-20%. If in fact the Century is detecting primarily lighter molecular weight gases, then the charcoal tube concentrations may actually be a better indication of harmful compounds present: particularly since the charcoal tubes allow identification of the compounds. The Century OVA merely gives an indication of total hydrocarbons. In any case the Century OVA can provide an immediate indication of the maximum possible concentrations present from which immediate decisions can be made. The charcoal tube samples can then be collected and the analysis can identify the specific compounds and their respective concentrations.

The correlations coefficients (in Table 14) indicate a very good

correlation between the Century OVA (PPM) total hydrocarbon concentrations and the charcoal tube concentrations of toluene (correlation coefficient: 0.82820 with $P<0.001$) at the Mill Creek Plant. There were also strong correlations between the Century OVA concentrations and methylisobutyl-ketone, chlorobenzene and benzene. The latter compounds were not routinely present, but were generally present when a peak occurred. These correlations were present only at the Mill Creek Plant and not at the two smaller plants. The total of the individual compounds found on the charcoal tubes did not correlate well with the Century OVA concentrations at any of the plants. At the Mill Creek Plant it may be feasible to merely monitor for toluene as an indication of routine peak concentrations, however, further documentation would be needed before toluene could be used as a marker compound.

The added ventilation at the Mill Creek Plant and the Little Miami Plant appeared to help decrease the total air concentrations by forcing fresh air back into the sewers rather than drawing air out and thereby shifting the equilibrium and encouraging volatilization. The ventilation grate at the Mill Creek Plant prior to entry of the wastewater into the bar screen area also appeared to decrease the wet well concentration as evidenced by the sampling conducted above this grate.

The water concentrations of individual compounds and total hydrocarbons indicated very low PPM to sub-PPM concentrations which did not allow adequate evaluation of Toogood and Hobson's (14) proposal. The concentrations detected never exceeded 55% of the proposed C_{TLV} and in most cases were less than 10% of the C_{TLV}. The RAT was never exceeded

since it is derived from the sum of the $C_{TLV's}$. The total concentration of the compounds detected in the water samples never exceeded 10% of the proposed RAT and in most cases represented less than 5% of the RAT.

The water concentrations did not correlate well with the Century OVA concentrations ($P \geq 0.10$) and in fact many of the correlation coefficients were slightly negative.

Both the Century OVA (and other direct reading instruments) and the charcoal tube sampling are important in characterizing sewer and wastewater atmospheres. The Century OVA can give an immediate indication of a potentially hazardous atmosphere. The use of this instrument can yield further information by placing a charcoal tube in front of the probe. If there is little or no change in the Century OVA reading, then the majority of the compounds are light molecular weight hydrocarbons and permanent gases such as methane, ethane and propane, which are relatively innocuous unless their concentrations are high enough to affect the % of available oxygen. If there is a drastic drop in the Century OVA reading, then further sampling should be done with charcoal tube and water samples to determine the identities of the compounds are present.

CONCLUSIONS

The studies conducted with the Century OVA (a direct reading instrument) indicated dramatic changes in total hydrocarbon concentrations both hourly as well as daily. The Century OVA readings were higher and more variable in the afternoon than in the morning at all three plants. The readings were also higher on the weekend than during the week at each plant. The readings were highest and the most variable at the Mill Creek Plant (the largest plant).

Total hydrocarbon concentrations quite often reached or exceeded 100 PPM while the water and air concentrations remained in the low PPM levels. This discrepancy indicates that a large percentage of the Century OVA concentrations are probably due to low molecular weight hydrocarbons and permanent gases such as methane, which are not collected on charcoal tubes. Even though the charcoal tube concentrations represented less than 10% of the Century OVA concentrations, there was a good correlation between high Century OVA readings and high concentrations of toluene, methylisobutylketone, chlorobenzene and benzene. These correlations were only found at the Mill Creek Plant and not at the two smaller plants. During the four week course of this study no TLV's, $C_{TLV's}$ or RAT's were exceeded.

The Century OVA can provide an immediate indication of the air quality and by using a charcoal tube in front of the probe, an estimate can be made of the degree of the hazard (i.e. % permanent gases).

A large hazardous slug was <u>not</u> detected at any time during this study. However, the possibility of a hazardous slug is always present.

Proper communication between industries and wastewater treatment plants should be paramount, particularly when a spill occurs. However, frequently the first notification of a hazardous slug is received via wastewater treatment workers. Perhaps, increased penalties to industry (for spills) coupled with more complete and frequent wastewater analysis of the influent (at least hourly) could prevent or at least alert workers to potential problems. The analytical proposal for headspace analysis of wastewater samples at the industries' effluent made by the Metropolitan Sewer District of Greater Cincinnati (MSD) would help industry "police itself." This proposal should also be instituted with respect to hourly sampling of wastewater influents as a form of "early warning device."

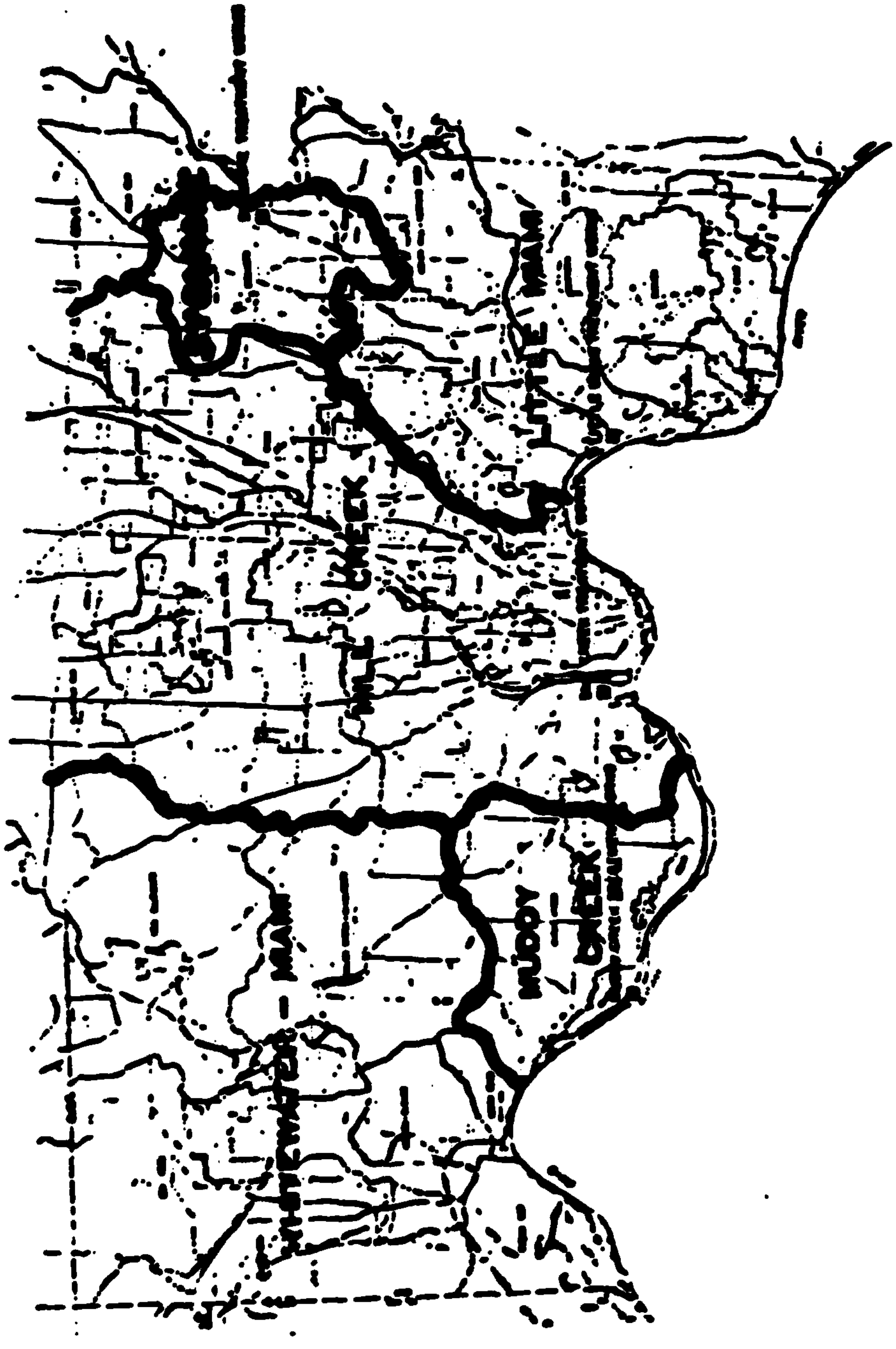
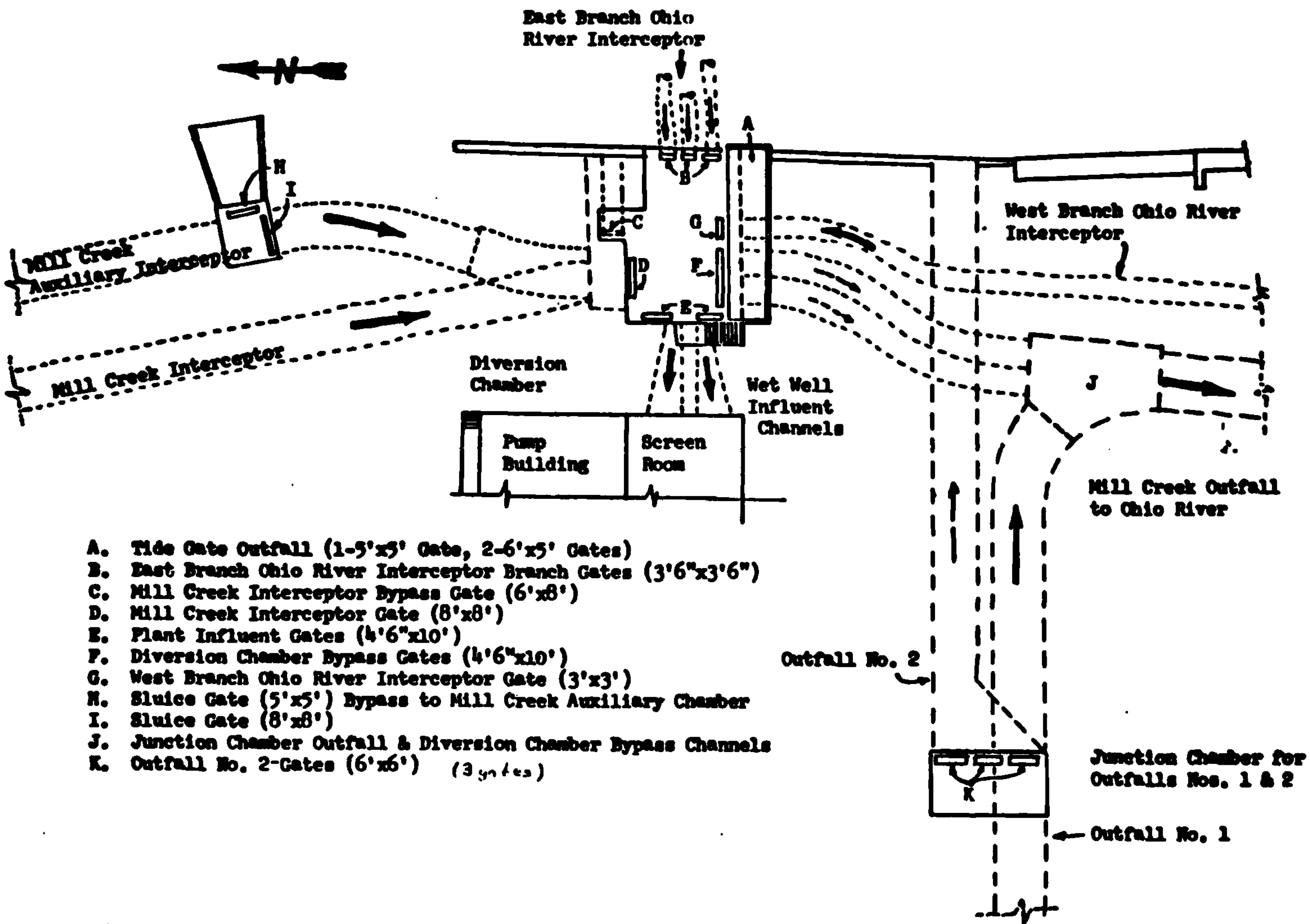


Figure 1. MSD Service Areas



A. Tide Gate Outfall (1-5'x5' Gate, 2-6'x5' Gates)
B. East Branch Ohio River Interceptor Branch Gates (3'6"x3'6")
C. Mill Creek Interceptor Bypass Gate (6'x8')
D. Mill Creek Interceptor Gate (8'x8')
E. Plant Influent Gates (4'6"x10')
F. Diversion Chamber Bypass Gates (4'6"x10')
G. West Branch Ohio River Interceptor Gate (3'x3')
H. Sluice Gate (5'x5') Bypass to Mill Creek Auxiliary Chamber
I. Sluice Gate (8'x8')
J. Junction Chamber Outfall & Diversion Chamber Bypass Channels
K. Outfall No. 2-Gates (6'x6') (3 gates)

Figure 2. Diagram of Mill Creek Interceptors

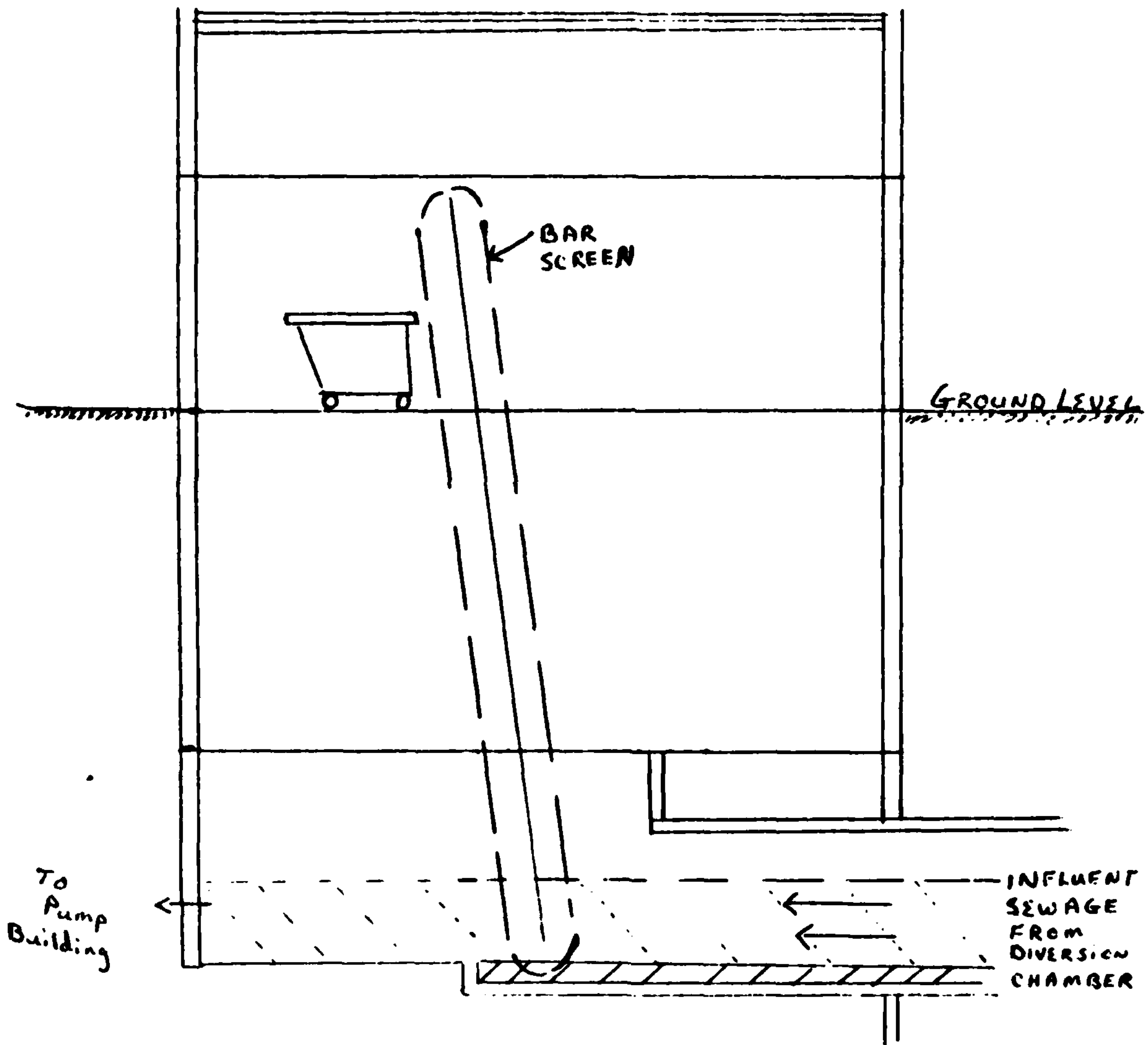


Figure 3. Schematic of an Automatic Bar Screen

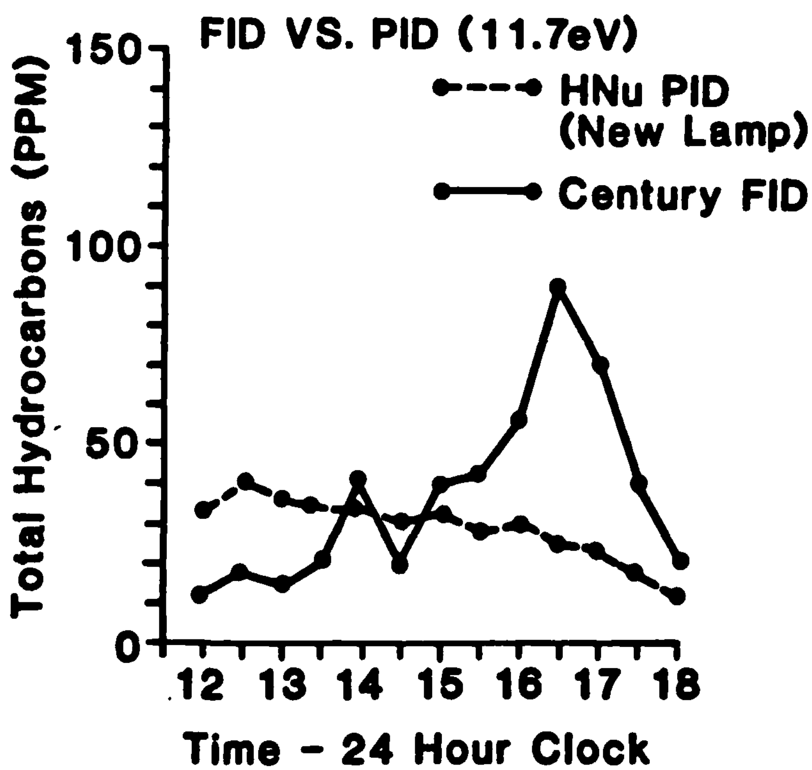


Figure 4. A Comparison of the Century OVA (FID) and the HNU (PID).

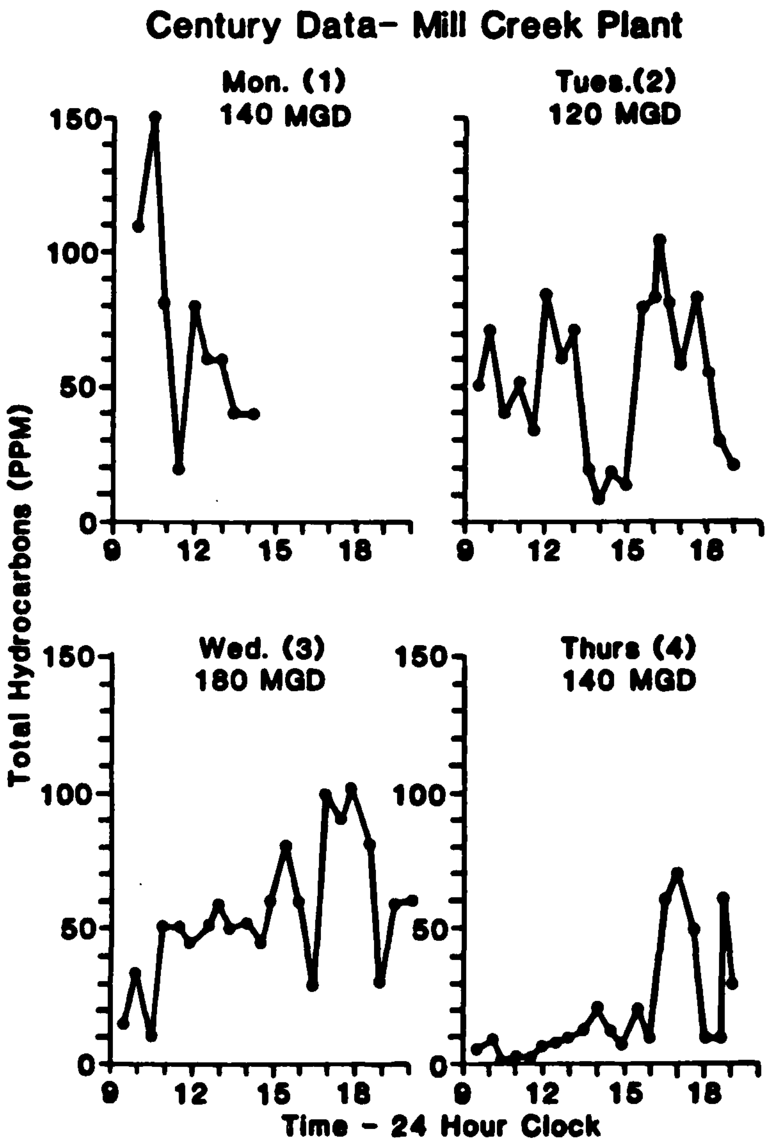


Figure 5. Century OVA Data.

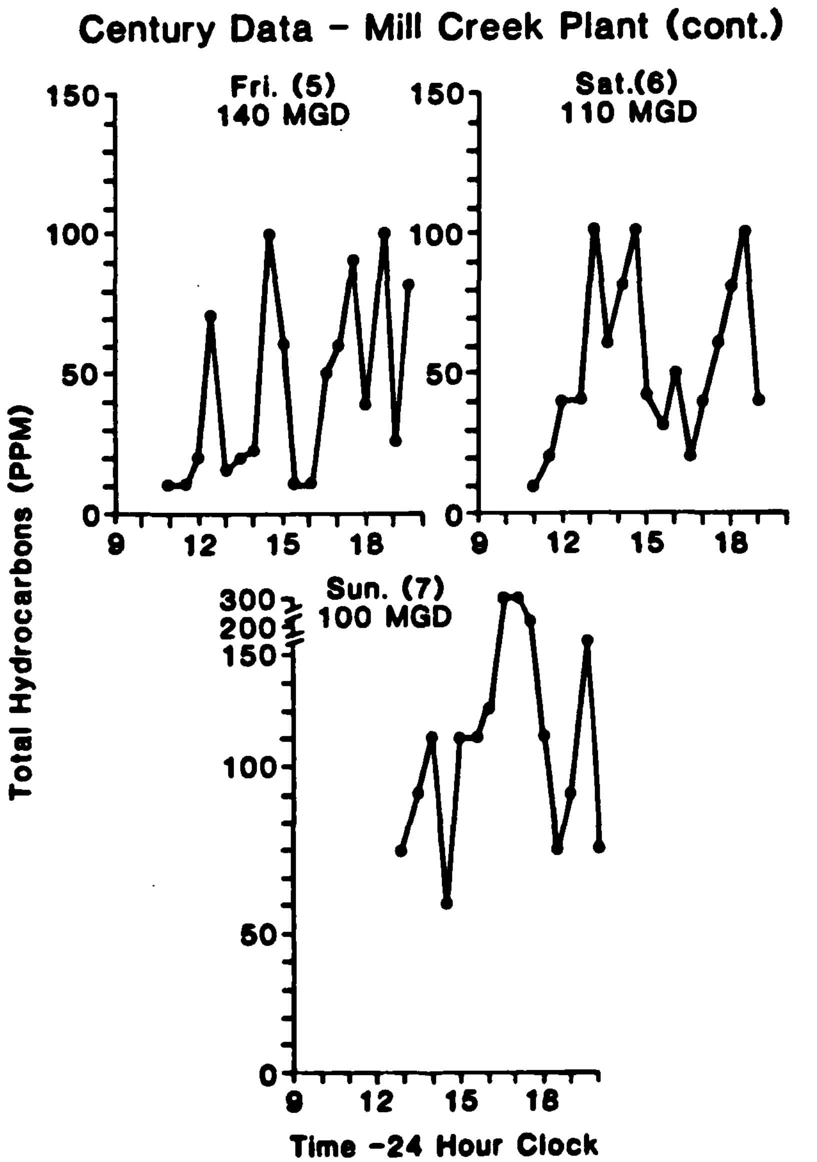


Figure 5 (continued). Century OVA Data.

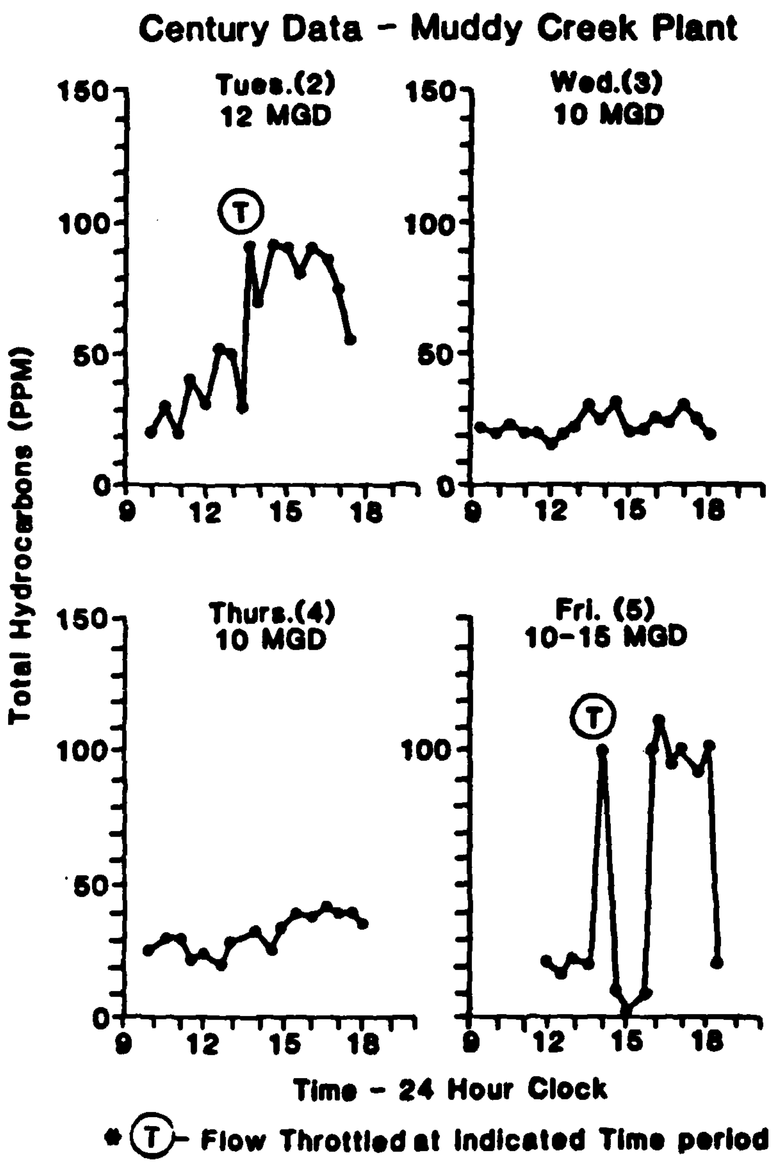


Figure 6. Century OVA Data.

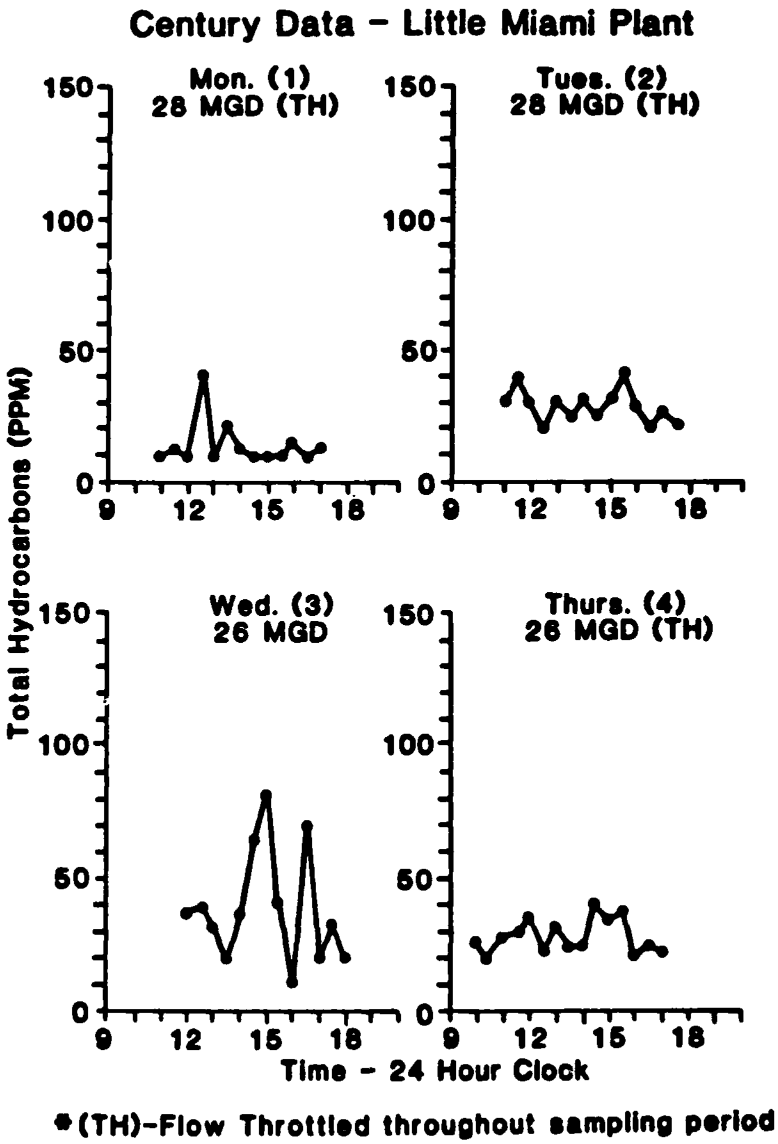


Figure 7. Century OVA Data.

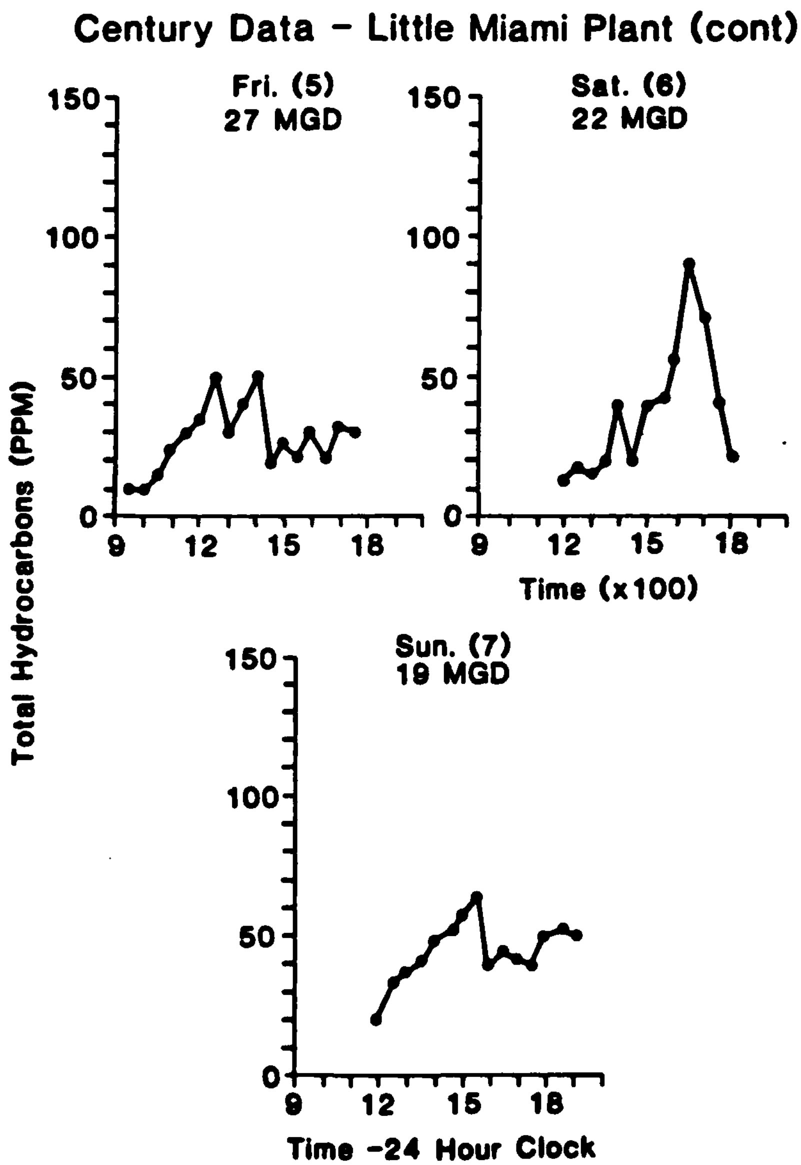


Figure 7 (continued). Century OVA Data.

TABLE 1

RELATIVE SENSITIVITIES OF THE CENTURY OVA

	Dry Air+	95% Humidity*
Toluene	100%	100%
Methane	83	80
Benzene	125	135
Trichloroethylene	58	65
Hexane	75	80
Methylene Chloride	85	100
Perchloroethylene	58	65
1,1,1-Trichloroethane	75	90

+Sensitivities published by manufacturer converted from methane to toluene basis.

*All standards were prepared in the presence of 90% humidity.

TABLE 2

INSTRUMENT PARAMETERS FOR GAS CHROMATOGRAPHIC ANALYSIS

OF CHARCOAL TUBE-AIR SAMPLES

Instruments:	Hewlett Packard (HP) 5710A Gas Chromatograph 7672A Automatic Liquid Samplers (ALS-99 samples) HP 1000 Series E Computer HP 3350 Lab Automation System	
Detector:	Flame Ionization Detector (FID)	
Carrier Gas:	Nitrogen	
Attenuation:	10 x 2 = 20	
Injection Port Temp.:	250°C	
Detector Temp.:	250°C	
Run Time:	30 Min.	
		Column Temp.
Column 1:	10 ft. 10% FFAP	100°C
Column 2:	20 ft. 5% FFAP	150°C and 200°C
Column 3:	6 ft. 5% Carbowax 20 M	100°C
Column 4:	10 ft. 5% SE-30	110°C

All columns 1/8 in. stainless steel coiled columns.

Computer Methods: ZR04, ZR05, ZR08, ZR09, ZR10.

Computer/ALS Sequence: ALS9.

TABLE 3

DETECTION LIMITS FOR COMPOUNDS DETERMINED BY GC ANALYSIS

OF CHARCOAL TUBE SAMPLES

Compound Screened	Abbreviation*	Detection Limits Mg
Freon 11	F-11	0.02
Chloroform	Chlor	0.02
Methylene Chloride	MeCl	0.02
Bromodichloromethane	$BrCl_2$	0.03
Dibromochloromethane	Br_2Cl	0.03
cis-1,2-Dichloroethylene	cDCE	0.01
1,2-Dichloroethane	DCA	0.01
1,1,1-Trichloroethane	Trich	0.01
Carbon Tetrachloride	CCl_4	0.10
Trichloroethylene	TCE	0.01
Perchloroethylene	PCE	0.01
Methyl Ethyl Ketone	MEK	0.01
Methyl iso-butyl Ketone	MIBK	0.01
Benzene	Bz	0.01
Toluene	Tol	0.01
Ethyl Benzene	E+Bz	0.01
Chlorobenzene	ClBz	0.01
o-Xylene	Xyl	0.01
m-Xylene	Xyl	0.01
p-Xylene	Xyl	0.01
o-Dichlorobenzene	Cl_2Bz	0.10
m-Dichlorobenzene	Cl_2Bz	0.10
p-Dichlorobenzene	Cl_2Bz	0.10
1,2,4-Trichlorobenzene	TCBZ	Not Detectable+

*As used in the data analysis.

+Not detectable using this method.

TABLE 4

INSTRUMENT PARAMETERS FOR ANALYSIS OF PURGEABLE HALOCARBONS IN WATER SAMPLES

Instrument:	Tracor 560 GC LSC-2 Sample Concentrator Tekmar Auto Lab Sampler Hewlett Packard (HP) 3352B Lab Data Reduction System
GC Detector:	Hall Electrolytic Conductivity Detector 700A (HECD)
Purge Gas:	40 ml/min. (helium)
Inert Carrier Gas:	Helium-40 ml/min.
Attenuation:	10 x 2 or 200
Solvent Flow:	4
Injection Port Temp.:	110°C
Detector Temp.:	250°C
Trap Temp.:	180°C

	Column 1	Column 2
	Carbopack B 60/80 Mesh	Porasil C-100/120 Mesh
	Coated with 1% SP-100	Coated with n-octane
	8 ft. x 0.1 in. ID stainless steel	6 ft. x 0.1 in. ID stainless steel
Initial Temp.:	44°C	50°C
Initial Hold:	3 min.	3 min.
Program Rate:	8°/min.	6°/min.
Final Temp.:	220°C	170°C
Final Hold:	15 min.	4 min.

Computer Method: PURG601:TO
Computer/ALS Sequence: SEQ21B-SEQ21F

TABLE 5

INSTRUMENT PARAMETERS FOR ANALYSIS OF PURGEABLE AROMATICS IN WATER SAMPLES

Instrument:	Tracor 560 GC LSC-2 Sample Concentrator Tekmar Auto Lab Sampler (ALS) Hewlett Packard (HP) 3352B Lab Data Reduction System
GC Detector:	Photoionization Detector (PID)-h-NU Systems PID-52-02
Purge Gas:	40 ml/min. (helium)
Inert Carrier Gas:	Helium 35 ml/min.
Attenuation:	10 x 6 or 160
Injection Port Temp.:	100°C
Detector Temp.:	250°C
Trap Temp.:	180°C

	Column 1	Column 2
	Suppelcoport 100/120 mesh coated with 5% SP-1200 and 1.75% Bentone-34 6 ft. x 0.085 in. ID stainless steel	Chromosorb W-AW 60/80 mesh coated with 1,2,3-Tris (2-cyanoethoxy)propane 6 ft. x 0.085 in. ID stainless steel
Initial Temp.:	50°C	40°C
Initial Hold:	2 min.	2 min.
Program Rate:	6°C/min.	2°C/min.
Final Temp.:	90°C	100°C
Final Hold:	20 min.	20 min.

Computer Method: PUR602:TO
Computer/ALS Sequence: SEQ22D-SEQ22H

TABLE 6

RETENTION TIMES AND DETECTION LIMITS FOR HALOCARBONS IN WATER SAMPLES

Compound	Abbreviation*	Retention Time**	Detection Limits ug/l
Methylene Chloride	MeCl	7.34	0.25
cis-1,2-Dichloroethylene	DCE	11.46	0.10
Chloroform	Chlor	12.02	0.05
1,2-Dichloroethane	DCA	12.77	0.03
1,1,1-Trichloroethane	Trich	14.08	0.03
Carbon Tetrachloride	CCl_4	14.45	0.12
Bromodichloromethane	$BrCl_2$	14.89	0.10
Trichloroethylene	TCE	17.15	0.12
Dibromochloromethane	Br_2Cl	17.70	0.09
Bromoform	Brom	20.45	0.20
Perchloroethylene	PCE	22.93	0.03

*As used in the data analysis.

**Retention times for column #1 (Carbopack B, 1% SP-1000) 8 ft.

TABLE 7

RETENTION TIMES AND DETECTION LIMITS FOR AROMATICS IN WATER SAMPLES

Compound	Abbreviation*	Retention Time**	Detection Limits ug/l
Methyl Ethyl Ketone	MEK	3.00	0.20
Benzene	Bz	3.44	0.20
Toluene	Tol	6.08	0.20
Ethylbenzene	EtBz	8.77	0.20
p-Xylene	Xyl	9.29	0.30
m-Xylene	Xyl	9.54	0.30
o-Xylene	Xyl	10.28	0.30
Chlorobenzene	ClBz	11.39	0.40
m-Dichlorobenzene	Cl_2Bz	17.61	0.30
o-Dichlorobenzene	Cl_2Bz	18.38	0.40
p-Dichlorobenzene	Cl_2Bz	24.33	0.40
1,2,4-Trichlorobenzene	TCBz	31.30	0.40

*As used in the data analysis.

**Retention times for column #1 (Suppelcoport 100/120 mesh coated with 5% SP-100 and 1.75% bentone-34, 6 ft.).

TABLE 8

SUMMARY OF ANALYTICAL SAMPLES COLLECTED

TABLE 8.1

SUMMARY OF ANALYTICAL SAMPLES COLLECTED

MILL CREEK

Number of Days Sampled	7
Number of Charcoal Tubes Sampled	28
Number of Peak Charcoal Tubes	14
Number of 8 Hour TWA Charcoal Tubes	7+
Number of Other Charcoal Tubes	7
Number of Water Samples*	19
Century OVA Data Points Recorded**	128

+ Actually represents 14 charcoal tubes since they were collected in series. Overnight samples were also collected but in almost all cases the batteries in the pumps died before morning so these sets of tubes in series were analyzed but not included in the data.

* Water samples were collected in duplicate to allow analysis for both aromatic and halocarbon compounds (i.e. 38 water samples were collected).

** Data Points recorded every 30 minutes for duration of sampling.

TABLE 8.2

SUMMARY OF ANALYTICAL SAMPLES COLLECTED

MUDDY CREEK

Number of Days Sampled	4
Number of Charcoal Tubes Sampled	13
Number of Peak Charcoal Tubes	8
Number of 8 Hour TWA Charcoal Tubes	4+
Number of Other Charcoal Tubes	1
Number of Water Samples*	9
Century OVA Data Points Recorded**	68

+ Actually represents 8 charcoal tubes since they were collected in series. Overnight samples were also collected but in almost all cases the batteries in the pumps died before morning so these sets of tubes in series were analyzed but not included in the data.

* Water samples were collected in duplicate to allow analysis for both aromatic and halocarbon compounds (i.e. 18 water samples were collected).

** Data Points recorded every 30 minutes for duration of sampling.

TABLE 8.3

SUMMARY OF ANALYTICAL SAMPLES COLLECTED

LITTLE MIAMI

Number of Days Sampled	7
Number of Charcoal Tubes Sampled	17
Number of Peak Charcoal Tubes	6
Number of 8 Hour TWA Charcoal Tubes	7+
Number of Other Charcoal Tubes	4
Number of Water Samples*	9
Century OVA Data Points Recorded**	101

+ Actually represents twice amount of charcoal tubes since they were collected in series. Overnight samples were also collected but in almost all cases the batteries in the pumps died before morning so these sets of tubes in series were analyzed but not included in the data.

* Water samples were collected in duplicate to allow analysis for both aromatic and halocarbon compounds (i.e. 18 water samples were collected).

** Data Points recorded every 30 minutes for duration of sampling.

TABLE 9

SAMPLING CONDITION INFORMATION

TABLE 9.0

Key For Tables 9.1-9.3

Spl = Sample Number (consecutive)

P = Plant

1 = Mill Creek

2 = Muddy Creek

3 = Little Miami

D = Day (1 = Mon, 2 = Tues, etc.)

= Number of sample for given day

Dt = Date in Month of August and September

Time = Time on 24 Hr. clock

PPM = Century Reading in PPM based on Toluene Std.

MGM = Calculated mg/m^3 from PPM (using Toluene)

FLO = Plant Flow in Millions of Gallons Per Day (MGD)

R = Ran, 1 = No Rain, 2 = Rain, 3 = Rain + Throttled Flow

S = Detergent, 1 = No Detergent, 2 = Detergent Present

C = Color, 1 = None, 2 = White, 3 = Red, 4 - Brown,

5 = Smell

pH = pH of Water using Indicator Paper (Scale 1-14)

AT = Air Temperature

WT = Water Temperature

H% = Relative Humidity %

TABLE 9.1

SAMPLING CONDITION INFORMATION AND CENTURY OVA AIR SAMPLING DATA

MILL CREEK WASTEWATER TREATMENT PLANT

SPL	P	E	#	DT	TIME	PPM	MOM	FLO	R	S	C	PH	AT	WT	SH
001	1	1	1	09	1000	110	424	110	1	1	1	7.0	82	73	74
002	1	1	2	09	1030	150	055	110	1	1	1	7.0	82	76	74
003	1	1	3	09	1100	080	301	130	1	1	1	7.0	82	76	74
004	1	1	4	09	1130	020	075	130	1	1	1	7.0	82	76	74
005	1	1	5	09	1200	000	301	140	1	1	1	7.0	82	76	74
006	1	1	6	09	1230	050	225	140	1	1	1	7.0	82	76	74
007	1	1	7	09	1300	030	223	140	1	1	1	7.0	82	76	74
008	1	1	8	09	1330	040	151	140	1	1	1	7.0	82	77	74
009	1	1	9	09	1400	040	151	140	1	1	1	7.0	82	77	74
010	1	2	1	10	0900	030	225	100	1	1	1	7.0	78	74	83
011	1	2	2	10	0930	050	155	120	1	1	1	7.0	78	74	83
012	1	2	3	10	1000	070	250	120	1	1	1	7.0	78	74	83
013	1	2	4	10	1030	040	151	120	1	1	1	7.0	78	74	83
014	1	2	5	10	1100	050	155	140	1	1	1	7.0	78	74	83
015	1	2	6	10	1130	034	121	140	1	1	1	7.0	78	74	83
016	1	2	7	10	1145	055	321	140	1	2	2	7.0	78	74	83
017	1	2	8	10	1200	030	310	140	1	2	2	7.0	78	74	83
018	1	2	9	10	1230	030	227	140	1	1	1	7.0	78	74	83
019	1	2	10	10	1300	070	250	140	1	1	1	7.0	78	74	83
020	1	2	11	10	1330	010	050	140	1	1	1	7.0	78	74	83
021	1	2	12	10	1400	005	030	140	1	1	1	7.0	78	74	83
022	1	2	13	10	1430	010	060	140	1	1	1	7.0	78	74	83
023	1	2	14	10	1500	014	050	140	1	1	1	7.0	78	74	83
024	1	2	15	10	1530	000	301	140	1	1	1	7.0	78	74	83
025	1	2	16	10	1600	002	305	140	1	1	1	7.0	78	74	83
026	1	2	17	10	1615	105	395	140	1	1	1	7.0	78	74	83
027	1	2	18	10	1630	030	301	140	1	1	1	7.0	78	74	83
028	1	2	19	10	1700	050	215	140	1	1	1	7.0	78	71	71
029	1	2	20	10	1730	004	317	140	1	1	1	7.0	78	71	71
030	1	2	21	10	1800	054	203	140	1	1	1	7.0	78	71	71
031	1	2	22	10	1830	030	113	140	1	1	1	7.0	78	71	71
032	1	2	23	10	1900	020	075	140	1	1	1	7.0	78	71	71

TABLE 9.1 (continued)

MILL CREEK WASTEWATER TREATMENT PLANT (CONTINUED

SPL	P	D	#	DY	TIME	PPM	MGA	FLO	R	S	C	PH	AT	WT	[illegible]
033	1	3	1	11	0900	025	094	200	2	2	2	7.0	73	69	82
034	1	3	2	11	0930	015	056	200	1	1	1	7.0	73	69	82
035	1	3	3	11	1000	034	123	200	1	1	1	7.0	73	69	82
036	1	3	4	11	1030	010	028	200	1	1	1	7.0	73	69	82
037	1	3	5	11	1100	050	137	200	1	1	1	7.0	73	69	82
038	1	3	6	11	1130	050	100	130	1	1	1	7.0	73	69	82
039	1	3	7	11	1200	045	159	130	1	1	1	7.0	73	69	82
040	1	3	8	11	1230	059	100	130	1	1	1	7.0	73	69	82
041	1	3	9	11	1300	050	223	130	1	1	1	7.0	73	69	82
042	1	3	10	11	1330	050	[illegible]	150	1	1	1	7.0	73	69	82
043	1	3	11	11	1400	052	197	150	1	1	1	7.0	73	69	82
044	1	3	12	11	1430	045	159	150	1	1	1	7.0	73	69	82
045	1	3	13	11	1500	050	223	150	1	1	1	7.0	73	69	82
046	1	3	14	11	1530	050	301	150	1	1	1	7.0	73	69	82
047	1	3	15	11	1600	050	227	150	1	1	1	7.0	73	69	82
048	1	3	16	11	1630	030	113	150	1	1	1	7.0	73	69	82
049	1	3	17	11	1700	100	370	150	1	1	1	7.5	74	70	82
050	1	3	18	11	1730	090	331	150	1	1	1	7.5	74	70	82
051	1	3	19	11	1800	100	377	150	1	1	1	7.5	74	70	82
052	1	3	20	11	1830	090	301	160	1	1	1	7.0	74	70	82
053	1	3	21	11	1900	030	112	140	1	1	1	7.0	74	70	82
054	1	3	22	11	1930	050	225	140	1	1	1	7.0	74	70	82
055	1	3	23	11	2000	050	227	140	1	1	1	7.0	74	70	82
056	1	4	1	12	0900	000	030	120	1	1	1	7.5	72	69	82
057	1	4	2	12	0930	005	027	120	1	2	2	7.5	72	69	82
058	1	4	3	12	1000	008	030	130	1	1	1	7.5	72	69	82
059	1	4	4	12	1030	002	003	120	1	1	1	7.5	72	69	82
060	1	4	5	12	1100	002	011	120	1	1	1	7.5	72	69	82
061	1	4	6	12	1130	003	011	120	1	1	1	7.5	72	69	82
062	1	4	7	12	1200	007	025	120	1	2	2	7.0	72	69	82
063	1	4	8	12	1230	008	030	120	1	1	1	7.0	72	69	82
064	1	4	9	12	1300	010	038	130	1	1	1	7.0	72	69	82

TABLE 9.1 (continued)

MILL CREEK WASTEWATER TREATMENT PLANT (CONTINUED

SPL	P	D	#	DT	TIME	PPM	MCM	FLO	R	S	C	PH	AT	WT	[illegible]
065	1	4	10	12	1330	012	045	130	1	1	1	7.0	72	68	82
066	1	4	11	12	1400	020	075	130	1	1	1	7.0	72	68	82
067	1	4	12	12	1430	012	030	130	1	1	1	7.0	72	68	82
068	1	4	13	12	1500	000	030	140	1	1	1	7.0	72	68	82
069	1	4	14	12	1530	020	075	140	1	1	1	7.0	72	68	82
070	1	4	15	12	1600	010	030	140	1	1	1	7.0	72	68	82
071	1	4	16	12	1630	060	225	140	1	1	1	7.0	75	66	62
072	1	4	17	12	1700	070	263	140	1	1	1	7.5	75	66	62
073	1	4	18	12	1730	050	188	140	1	1	1	7.0	75	66	62
074	1	4	19	12	1800	010	038	140	1	1	1	7.5	75	66	62
075	1	4	20	12	1830	010	030	140	1	1	1	7.5	75	66	62
076	1	4	21	12	1835	050	188	140	1	1	1	7.5	75	66	62
077	1	4	22	12	1845	060	225	120	1	1	1	7.5	75	66	62
078	1	4	23	12	1900	030	113	140	1	1	1	7.5	75	66	62
079	1	5	1	13	1100	010	030	140	1	1	1	7.0	73	65	65
080	1	5	2	13	1130	010	030	120	1	1	1	7.0	73	65	65
081	1	5	3	13	1200	020	075	120	1	1	1	7.0	73	65	65
082	1	5	4	13	1230	070	263	120	1	1	1	7.0	73	65	65
083	1	5	5	13	1300	015	056	120	1	1	1	7.0	73	65	65
084	1	5	6	13	1330	020	075	120	1	1	1	7.0	73	65	65
085	1	5	7	13	1400	022	083	140	1	1	1	7.0	73	65	65
086	1	5	8	13	1430	100	375	140	1	1	2	7.0	73	65	65
087	1	5	9	13	1500	060	225	140	1	1	1	7.0	73	65	65
088	1	5	10	13	1530	010	038	140	1	1	1	6.5	75	60	60
089	1	5	11	13	1600	010	038	140	1	2	3	7.0	75	60	60
090	1	5	12	13	1630	050	188	140	1	2	3	7.0	75	60	60
091	1	5	13	13	1700	030	225	140	1	1	1	7.0	75	60	60
092	1	5	14	13	1730	090	338	140	1	1	1	7.0	75	60	60
093	1	5	15	13	1800	040	151	140	1	1	1	6.5	75	65	59
094	1	5	16	13	1830	100	375	140	1	2	4	6.5	75	65	57
095	1	5	17	12	1900	026	098	140	1	1	1	6.5	75	65	59
096	1	5	18	13	1930	080	301	140	1	1	1	6.5	75	65	59

TABLE 9.1 (continued)

MILL CREEK WASTEWATER TREATMENT PLANT (CONTINUED)

SPL	P	D	#	DY	TIME	PPM	MGM	FLO	R	S	C	PH	AT	WT	ST
097	1	6	1	14	1100	010	038	100	1	1	1	7.0	75	66	62
098	1	6	2	14	1130	020	075	100	1	1	1	7.0	75	66	62
099	1	6	3	14	1200	040	151	110	1	1	1	7.0	75	66	62
100	1	6	4	14	1230	040	151	110	1	1	1	7.0	75	66	62
101	1	6	5	14	1300	100	376	110	1	1	1	7.0	75	66	62
102	1	6	6	14	1330	060	226	110	1	1	1	7.0	75	66	62
103	1	6	7	14	1400	080	301	110	1	1	1	7.0	75	66	62
104	1	6	8	14	1430	100	376	110	1	1	1	7.0	75	66	62
105	1	6	9	14	1500	040	151	110	1	1	1	7.0	75	66	62
106	1	6	10	14	1530	030	113	110	1	1	1	7.0	75	66	62
107	1	6	11	14	1600	050	188	110	1	1	1	7.0	76	69	62
108	1	6	12	14	1630	020	075	110	1	1	1	7.0	76	69	62
109	1	6	13	14	1700	040	151	110	1	1	1	7.0	76	69	69
110	1	6	14	14	1730	060	226	110	1	1	1	7.0	76	69	62
111	1	6	15	14	1800	080	301	110	1	1	1	7.0	76	69	62
112	1	6	16	14	1830	100	376	110	1	1	1	7.0	76	69	62
113	1	6	17	14	1900	040	151	110	1	1	1	7.0	76	69	62
114	1	7	1	15	1300	050	188	100	1	1	1	6.5	77	70	71
115	1	7	2	15	1330	100	376	100	1	1	1	6.5	77	70	71
116	1	7	3	15	1400	120	452	100	1	1	1	6.5	77	70	71
117	1	7	4	15	1430	060	226	100	1	1	1	7.0	77	70	71
118	1	7	5	15	1500	120	452	100	1	1	1	7.0	77	70	71
119	1	7	6	15	1530	120	452	100	1	1	1	7.0	77	70	71
120	1	7	7	15	1600	130	489	100	1	1	1	7.0	77	70	71
121	1	7	8	15	1630	300	1129	100	1	1	1	7.0	77	71	71
122	1	7	9	15	1700	300	1129	100	1	1	1	7.0	77	71	71
123	1	7	10	15	1730	210	790	100	1	1	1	7.0	77	71	71
124	1	7	11	15	1800	120	452	100	1	1	1	7.0	77	71	71
125	1	7	12	15	1830	080	301	100	1	1	1	7.0	77	71	71
126	1	7	13	15	1900	100	376	100	1	1	1	7.0	77	71	71
127	1	7	14	15	1930	160	602	100	1	1	1	7.0	77	71	71
128	1	7	15	15	2000	080	301	100	1	1	1	7.0	77	71	71

TABLE 9.2

SAMPLING CONDITION INFORMATION AND CENTURY OVA AIR SAMPLING DATA

MUDDY CREEK WASTEWATER TREATMENT PLANT

SPL	P	D	#	DT	TIME	PPM	MGM	FLO	R	S	C	PH	AT	VT	RH
129	2	2	1	17	1000	020	075	010	1	1	1	7.0	72	74	93
130	2	2	2	17	1030	030	113	010	1	1	1	7.0	72	74	93
131	2	2	3	17	1100	020	075	010	1	1	1	7.0	72	74	93
132	2	2	4	17	1130	040	151	010	1	1	1	7.0	72	74	93
133	2	2	5	17	1200	032	120	010	1	1	1	7.0	72	74	93
134	2	2	6	17	1230	052	195	010	1	1	1	7.0	72	74	93
135	2	2	7	17	1300	050	188	010	1	1	1	7.0	72	74	93
136	2	2	8	17	1330	030	113	010	1	1	1	7.0	72	74	93
137	2	2	9	17	1350	090	339	010	1	1	1	7.0	72	74	93
138	2	2	10	17	1400	070	263	010	1	1	1	7.0	72	74	93
139	2	2	11	17	1430	092	343	010	1	1	1	7.0	72	74	93
140	2	2	12	17	1500	090	339	010	1	1	1	7.0	72	74	93
141	2	2	13	17	1530	080	301	010	1	1	1	7.0	72	74	93
142	2	2	14	17	1600	090	339	010	1	1	1	7.0	72	74	93
143	2	2	15	17	1630	[illegible]	324	010	1	1	1	7.0	72	74	93
144	2	2	16	17	1700	075	283	010	1	1	1	7.0	72	74	93
145	2	2	17	17	1730	056	211	010	1	1	1	7.0	72	74	93
146	2	3	1	18	0900	020	075	010	1	1	1	6.5	72	70	[illegible]
147	2	3	2	18	0930	022	083	010	1	1	1	6.5	73	70	83
148	2	3	3	18	1000	020	075	010	1	1	1	7.0	73	70	85
149	2	3	4	18	1030	024	090	010	1	1	1	7.0	73	70	85
150	2	3	5	18	1100	020	075	010	1	1	1	7.0	73	70	85
151	2	3	6	18	1130	020	075	010	1	1	1	7.0	73	70	85
152	2	3	7	18	1200	015	056	010	1	1	1	7.0	73	70	[illegible]
153	2	3	8	18	1230	020	075	010	1	1	1	7.0	73	70	85
154	2	3	9	18	1300	022	083	010	1	1	1	7.0	73	70	85
155	2	3	10	18	1330	030	113	010	1	1	1	7.0	73	70	90
156	2	3	12	18	1400	025	094	010	1	1	1	7.0	73	70	85
157	2	3	13	18	1430	032	120	010	1	1	1	7.0	73	70	[illegible]
158	2	3	14	18	1500	020	075	010	1	1	1	7.0	73	70	85
159	2	3	15	18	1530	022	083	010	1	1	1	7.0	73	70	85
160	2	3	16	18	1600	024	092	010	1	1	1	7.0	73	70	90
161	2	3	17	18	1630	024	090	010	1	1	1	7.0	73	70	90
162	2	3	18	18	1700	030	113	010	1	1	1	7.0	73	70	85
163	2	3	19	18	1730	024	090	010	1	1	1	7.0	73	70	85

TABLE 9.2 (continued)

MUDDY CREEK WASTEWATER TREATMENT PLANT (CONTINUED)

SPL	P	D	#	DT	TIME	PPM	AGM	FLO	R	S	C	PH	AT	WT	SH
164	2	3	20	19	1900	020	075	010	1	1	1	7.0	73	70	93
165	2	4	1	19	1000	025	090	010	1	1	1	7.0	73	70	93
166	2	4	2	19	1030	030	113	010	1	1	1	7.0	73	70	88
167	2	4	3	19	1100	030	113	010	1	1	1	7.0	73	70	93
168	2	4	4	19	1130	022	083	010	1	1	1	7.0	73	70	88
169	2	4	5	19	1200	024	090	010	1	1	1	7.0	73	70	83
170	2	4	6	19	1230	020	075	010	1	1	1	7.0	73	70	93
171	2	4	7	19	1300	022	105	010	1	1	1	7.0	73	70	93
172	2	4	8	19	1330	030	113	010	1	1	1	7.0	73	70	93
173	2	4	9	19	1400	032	120	010	1	1	1	7.0	73	70	93
174	2	4	10	19	1430	025	093	010	1	1	1	7.0	73	70	83
175	2	4	11	19	1500	034	120	010	1	1	1	7.0	73	70	93
176	2	4	12	19	1530	040	151	010	1	1	1	7.0	73	70	93
177	2	4	13	19	1600	038	143	010	1	1	1	7.0	73	70	93
178	2	4	14	19	1630	042	158	010	1	1	1	7.0	73	70	93
179	2	4	15	19	1700	040	151	010	1	1	1	7.0	73	70	93
180	2	4	16	19	1730	040	151	010	1	1	1	7.0	73	70	93
181	2	4	17	19	1800	036	135	010	1	1	1	7.0	73	70	93
182	2	5	1	20	1200	020	075	010	1	1	1	6.5	72	73	93
183	2	5	2	20	1230	016	060	010	1	1	1	6.5	72	73	93
184	2	5	3	20	1300	022	083	010	1	1	1	6.5	72	73	93
185	2	5	4	20	1330	020	075	010	1	1	1	6.5	72	73	93
186	2	5	5	20	1400	100	376	015	2	1	1	7.0	72	73	93
187	2	5	6	20	1430	010	038	015	2	1	1	7.0	72	73	93
188	2	5	7	20	1500	002	008	015	1	1	1	7.0	72	73	93
189	2	5	8	20	1530	008	030	015	1	1	1	7.0	72	73	93
190	2	5	9	20	1600	100	376	010	1	1	5	5.5	72	73	95
191	2	5	10	20	1605	110	414	010	1	1	5	5.5	72	73	95
192	2	5	11	20	1630	095	357	010	1	1	1	6.5	72	73	95
193	2	5	12	20	1700	100	376	010	1	1	1	6.5	72	73	95
194	2	5	13	20	1730	092	346	010	1	1	1	6.5	72	73	93
195	2	5	14	20	1800	100	376	010	1	1	1	6.5	72	73	93
196	2	5	15	20	1830	020	075	010	1	1	1	6.5	72	73	93

TABLE 9.3

SAMPLING CONDITION INFORMATION AND

CENTURY OVA AIR SAMPLING DATA

LITTLE MIAMI WASTEWATER TREATMENT PLANT

SPL	P	D	#	DT	TIME	PPM	MGM	FLO	R	S	C	PH	AT	WT	SH
197	3	1	1	30	1100	010	038	020	2	1	1	7.0	74	75	95
198	3	1	2	30	1130	012	045	020	2	1	1	7.0	74	75	95
199	3	1	3	30	1200	010	038	020	3	1	1	7.0	74	75	95
200	3	1	4	30	1230	040	151	028	3	1	1	7.0	74	75	95
201	3	1	5	30	1300	010	038	020	3	1	1	7.0	74	75	95
202	3	1	6	30	1330	020	075	020	3	1	1	7.0	74	75	95
203	3	1	7	30	1400	012	045	020	3	1	1	7.0	74	75	95
204	3	1	8	30	1430	010	038	020	3	1	1	7.0	74	75	95
205	3	1	9	30	1500	010	038	020	3	1	1	7.0	74	75	95
206	3	1	10	30	1530	010	038	020	3	1	1	7.0	74	75	95
207	3	1	11	30	1600	014	053	020	3	1	1	7.0	74	75	95
208	3	1	12	30	1630	010	038	020	3	1	1	7.0	74	75	95
209	3	1	13	30	1700	012	045	020	3	1	1	7.0	74	75	95
210	3	2	1	31	1100	030	113	020	3	1	1	7.0	73	74	95
211	3	2	2	31	1130	040	151	020	3	1	1	7.0	73	74	95
212	3	2	3	31	1200	030	113	020	3	1	1	7.0	73	74	95
213	3	2	4	31	1230	020	075	020	3	1	1	7.0	73	74	95
214	3	2	5	31	1300	030	113	020	3	1	1	7.0	73	74	95
215	3	2	6	31	1330	025	094	020	3	1	1	7.0	76	74	95
216	3	2	7	31	1400	030	113	020	3	1	1	7.0	73	74	95
217	3	2	8	31	1430	025	094	020	3	1	1	7.0	73	74	95
218	3	2	9	31	1500	030	113	020	3	1	1	7.0	73	74	95
219	3	2	10	31	1530	040	151	020	3	1	1	7.0	73	74	95
220	3	2	11	31	1600	028	105	020	3	1	1	7.0	76	74	95
221	3	2	12	31	1630	020	075	020	3	1	1	7.0	73	74	95
222	3	2	13	31	1700	015	056	020	3	1	1	7.0	76	74	95
223	3	2	14	31	1730	022	083	020	3	1	1	7.0	73	74	95
224	3	3	1	01	1200	038	143	023	1	1	1	6.5	75	74	95
225	3	3	2	01	1230	040	151	023	1	1	1	6.5	75	74	95
226	3	3	3	01	1300	032	120	023	1	1	1	6.5	75	74	95
227	3	3	4	01	1330	020	075	023	1	1	1	6.5	75	74	95
228	3	3	5	01	1400	036	135	023	1	1	1	6.5	75	74	95
229	3	3	6	01	1430	065	245	023	1	1	1	6.5	75	74	95
230	3	3	7	01	1500	080	301	023	1	1	1	6.5	75	74	95

TABLE 9.3 (continued)

LITTLE MIAMI WASTEWATER TREATMENT PLANT (CONTINUED)

SPL	P	D	#	DT	TIME	PPM	MGM	FLO	R	S	C	PH	AT	WT	RH
231	3	3	8	01	1530	040	151	023	1	1	1	6.5	75	74	95
232	3	3	9	01	1600	010	030	023	1	1	1	6.5	75	74	95
233	3	3	10	01	1630	070	263	023	1	1	1	6.5	75	74	95
234	3	3	11	01	1700	020	075	023	1	1	1	6.5	75	74	95
235	3	3	12	01	1730	032	120	023	1	1	1	6.5	75	74	95
236	3	3	13	01	1800	020	075	023	1	1	1	6.5	75	74	95
237	3	4	1	02	1000	025	090	023	1	1	1	6.5	75	74	95
238	3	4	2	02	1030	020	075	023	1	1	1	6.5	75	74	95
239	3	4	3	02	1100	020	105	023	1	1	1	6.5	75	74	95
240	3	4	4	02	1130	030	113	023	1	1	1	6.5	75	74	95
241	3	4	5	02	1200	036	135	023	1	1	1	6.5	75	74	95
242	3	4	6	02	1230	022	083	023	1	1	1	6.5	75	74	95
243	3	4	7	02	1300	032	120	023	1	1	1	6.5	75	74	95
244	3	4	8	02	1315	028	105	023	1	1	1	6.5	75	74	95
245	3	4	9	02	1330	024	090	023	1	1	1	6.5	75	74	95
246	3	4	10	02	1400	024	090	023	1	1	1	6.5	75	74	95
247	3	4	11	02	1430	040	151	023	1	1	1	6.5	75	74	95
248	3	4	12	02	1500	034	128	023	1	1	1	6.5	75	74	95
249	3	4	13	02	1530	036	135	023	1	1	1	6.5	75	74	95
250	3	4	14	02	1300	020	075	023	1	1	1	6.5	75	74	95
251	3	4	15	02	1630	024	090	023	1	1	1	6.5	75	74	95
252	3	4	16	02	1700	022	083	023	2	1	1	7.0	75	74	95
253	3	5	1	03	0930	010	030	027	1	1	1	7.0	75	55	81
254	3	5	2	03	1000	010	038	027	1	1	1	7.0	75	74	95
255	3	5	3	03	1030	015	056	027	1	1	1	7.0	75	74	95
256	3	5	4	03	1100	025	094	027	1	1	1	7.0	75	74	95
257	3	5	5	03	1130	030	113	027	1	1	1	7.0	75	74	95
258	3	5	6	03	1200	034	128	027	1	1	1	7.0	75	74	95
259	3	5	7	03	1230	050	188	027	1	1	1	7.0	75	74	95
260	3	5	8	03	1300	030	113	027	1	1	1	7.0	75	74	95
261	3	5	9	03	1330	040	151	023	1	1	1	7.0	75	74	95
262	3	5	10	03	1400	050	188	023	1	1	1	7.0	75	74	95
263	3	5	11	3	1430	020	075	023	1	1	1	7.0	75	74	95

TABLE 9.3 (continued)

LITTLE MIAMI WASTEWATER TREATMENT PLANT (CONTINUED)

SPL	P	D	# DT	TIME	PPM	MCM	FLO	R	S	C	PH	AT	WT	S%
264	3	5	1203	1500	026	093	026	1	1	1	7.0	75	74	95
265	3	5	1303	1530	022	083	026	1	1	1	7.0	75	74	95
266	3	5	1403	1600	030	113	026	1	1	1	7.0	75	74	95
267	3	5	1503	1630	020	075	026	1	1	1	7.0	75	74	95
268	3	5	1603	1700	032	120	026	1	1	1	7.0	75	74	95
269	3	5	1703	1730	030	113	026	1	1	1	7.0	75	74	95
270	3	6	1 04	1200	012	045	022	1	1	1	6.5	71	63	64
271	3	6	2 04	1230	010	038	022	1	1	1	6.5	71	63	64
272	3	6	3 04	1300	013	049	022	1	1	1	6.5	71	63	64
273	3	6	4 04	1330	020	075	022	1	1	1	6.5	71	63	64
274	3	6	5 04	1400	040	151	022	1	1	1	6.5	71	63	64
275	3	6	6 04	1430	020	075	022	1	1	1	6.5	71	63	64
276	3	6	7 04	1500	040	151	022	1	1	1	6.5	71	63	64
277	3	6	8 04	1530	042	158	022	1	1	1	6.5	71	63	64
278	3	6	9 04	1600	056	211	022	1	1	1	6.5	71	63	64
279	3	6	1004	1630	090	339	022	1	1	1	6.5	71	63	64
280	3	6	1104	1700	070	263	022	1	1	1	6.5	71	63	64
281	3	6	1204	1730	040	151	022	1	1	1	6.5	71	63	64
282	3	6	1304	1800	020	075	022	1	1	1	6.5	71	63	64
283	3	7	1 05	1200	020	075	019	1	1	1	7.0	71	67	65
284	3	7	2 05	1230	034	128	019	1	1	1	7.0	71	67	65
285	3	7	3 05	1300	038	143	019	1	1	1	7.0	71	67	65
286	3	7	4 05	1330	042	158	019	1	1	1	7.0	71	67	65
287	3	7	5 05	1400	040	151	019	1	1	1	7.0	71	67	65
288	3	7	6 05	1430	052	196	019	1	1	1	7.0	71	67	65
289	3	7	7 05	1500	056	211	019	1	1	1	7.0	71	67	65
290	3	7	8 05	1530	064	241	019	1	1	1	7.0	71	67	65
291	3	7	9 05	1600	040	151	019	1	1	1	7.0	71	67	65
292	3	7	1005	1630	046	173	019	1	1	1	7.0	71	67	65
293	3	7	1105	1700	042	158	019	1	1	1	7.0	71	67	65
294	3	7	1205	1730	040	151	019	1	1	1	7.0	71	67	65
295	3	7	1305	1800	050	188	019	1	1	1	7.0	71	67	65
296	3	7	1405	1830	052	196	019	1	1	1	7.0	71	67	65
297	3	7	1505	1900	050	188	019	1	1	1	7.0	71	67	65

TABLE 10

PEARSON CORRELATIONS FOR SAMPLING CONDITION

DATA COMPARED TO CENTURY OVA DATA (ppm)

	Mill Creek	Muddy Creek	Little Miami
Flow	-0.30112 ****	-.09656 *	-0.47012 ****
Time	0.28294 ***	0.42529 ****	0.26308 ***
Day	0.28558 ****	-0.03210 *	0.43885 ****
Rain	-0.06056 *	0.08456 *	-0.87108 ****
DET	-0.03344 *	--	--
Color	0.04488 *	0.38817 ***	--
pH	-0.17020 **	-0.26487 **	-0.16762 **
Air Temperature	0.35366 ****	-0.51863 ****	-0.27862 ***
Water Temperature	0.23388 ***	0.51987 ****	-0.34161 ****
Humidity	-0.12786 *	0.56456 ****	-0.21257 **

* P<1.0
** P<0.10
*** P<0.01
**** P<0.001

TABLE 11

RESULTS OF ANALYSIS OF CHARCOAL TUBE AIR SAMPLES

COLLECTED DURING PERIODS OF PEAK EPISODES

OBSERVED ON CENTURY OVA

TABLE 11.0

Key For Tables 11.1-11.3, 12, 13

Spl = Sample Number (coincides with Century Spl #'s)

ID = Internal ID Number

P = Phase, 1 = Air, 2 = Water

CTRIC = 1,1,1-Trichloroethane

CBENZ = Benzene

CTCE = Trichloroethylene

CPCE = Perchloroethylene/1,1,2,2-Tetrachloroethylene

CTOL = Toluene

CXYL = Xylene

CCLBZ = Chlorobenzene

CMEK = Methyl Ethyl Ketone/2-Butanane

CMIBK = Methyl Iso Butylketone

CTPPM = Total PPM of Individual Compounds

CTMGM = Total mg/m^3

CZPPM = Total peak area expressed as Toluene in PPM

CZMGM = Total peak area expressed as Toluene in mg/m^3

NOTE = 1 = Peak - No Water Sample Collected

2 = Tube placed in front of Century Inlet

3 = Outside Grill

4 = Inside Grill

5 = One Floor Above Bar Screen

*Concentrations reflect total of front plus back of charcoal tube; at no time did the concentration in the back section exceed 25% of the concentration in the front section

TABLE 11.1

RESULTS OF ANALYSIS OF CHARCOAL TUBE AIR SAMPLES COLLECTED DURING PERIODS OF PEAK EPISODES OBSERVED ON CENTURY OVA

CHARCOAL TUBE SAMPLE ANALYSIS

SAMPLES COLLECTED DURING CENTURY PEAKS

MILL CREEK WASTEWATER TREATMENT PLANT

SPL	ID	P	CTRIC	CBENZ	CTCE	CPCE	CTOL	CXYL	CCLBZ	CMEK	CMIBK	CTPPM	CTMGM	CZPPM	CZMGM
026	05	1	04.34	01.45	0.00	0.00	02.02	0.00	0.00	0.00	13.11	007.81	050.10	012.15	045.78
049	10	1	00.92	00.50	02.06	01.35	01.15	0.00	0.00	0.00	0.00	005.98	031.23	003.65	013.78
057	13	1	0.00	0.00	0.00	0.00	00.02	0.00	0.00	0.00	0.00	000.02	000.06	000.02	000.08
062	14	1	00.56	00.04	0.00	00.07	00.05	0.00	0.00	0.00	0.00	000.82	004.39	000.20	000.76
071	15	1	01.04	00.16	0.00	00.07	00.06	0.00	0.00	02.68	00.37	001.33	009.96	000.93	003.52
073	17	1	0.00	0.00	0.00	04.84	0.00	0.00	0.00	54.01	0.00	004.84	096.85	010.54	039.73
082	21	1	01.27	00.08	0.00	00.08	00.11	0.00	0.00	01.11	0.00	001.53	009.22	000.66	002.47
087	22	1	01.53	00.10	00.05	00.11	00.08	0.00	0.00	0.00	0.00	001.87	010.01	000.78	002.97
091	23	1	02.07	00.44	01.45	00.82	00.30	00.01	0.00	0.00	0.00	005.09	027.31	002.28	008.61
094	24	1	01.56	00.08	03.42	0.00	00.93	0.00	00.21	05.73	0.00	007.45	042.35	004.76	017.92
104	30	1	01.60	00.75	0.00	01.33	00.57	0.00	01.73	0.00	03.42	006.03	034.03	004.99	018.82
112	31	1	00.84	00.25	00.04	00.10	00.12	0.00	0.00	0.00	0.00	001.34	006.79	000.71	002.65
121	37	1	0.00	01.83	0.00	0.00	04.03	0.00	01.53	0.00	13.25	007.39	042.63	018.02	067.91
127	33	1	0.00	00.50	0.00	0.00	00.92	0.00	00.94	0.00	05.55	002.35	015.26	006.08	022.91

TABLE 11.2

RESULTS OF ANALYSIS OF CHARCOAL TUBE AIR SAMPLES COLLECTED DURING PERIODS OF PEAK EPISODES OBSERVED ON CENTURY OVA

CHARCOAL TUBE SAMPLE ANALYSIS

SAMPLES COLLECTED DURING CENTURY PEAKS

MUDDY CREEK WASTEWATER TREATMENT PLANT

SPL	ID	P	CTRIC	CBENZ	CTCE	CPCE	CTOL	CXYL	CCLBZ	CMEK	CMIBK	CTPPM	CTMGM	CZPPM	CZMGM
138	43	1	0.00	00.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000.10	000.31	000.02	000.07
140	44	1	0.00	00.29	0.00	0.00	02.14	0.00	0.00	0.00	0.00	002.43	009.02	002.55	009.53
143	45	1	0.00	00.18	0.00	0.00	00.77	0.00	0.00	0.00	0.00	000.95	003.47	000.97	003.67
157	48	1	0.00	00.01	0.00	0.00	00.09	0.00	0.00	0.00	0.00	000.10	000.38	000.07	000.25
176	51	1	0.00	00.99	0.00	01.23	00.11	0.00	0.00	0.00	0.00	002.28	011.91	002.02	007.60
186	54	1	0.00	02.01	00.34	19.73	0.00	0.00	0.00	05.32	0.00	030.07	190.35	011.57	043.56
191	55	1	0.00	00.14	0.00	01.44	00.33	0.00	0.00	0.00	02.08	001.91	013.56	001.70	006.39
193	55	1	0.00	01.66	06.07	15.92	0.00	0.00	0.00	0.00	0.00	022.65	145.90	009.43	035.53

TABLE 11.3

RESULTS OF ANALYSIS OF CHARCOAL TUBE AIR SAMPLES COLLECTED DURING

PERIODS OF PEAK EPISODES OBSERVED ON CENTURY OVA

CHARCOAL TUBE SAMPLE ANALYSIS

SAMPLES COLLECTED DURING CENTURY PEAKS

LITTLE MIAMI WASTEWATER TREATMENT PLANT

SPL	ID	P	CTRIC	CBENZ	CTCE	CPCE	CTOL	CXYL	CCLBZ	CMEK	CMIBK	CTPPM	CTMGM	CZPPM	CZMGM
222	64	1	00.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000.69	003.75	000.49	001.85
230	67	1	0.00	00.55	35.25	16.65	05.45	0.00	0.00	0.00	0.00	035.93	353.00	061.09	233.20
244	71	1	0.00	00.09	0.00	00.21	0.00	0.00	0.00	02.55	0.00	000.30	004.64	001.15	004.36
254	75	1	0.00	02.50	10.96	03.91	02.15	0.00	0.00	0.00	0.00	019.52	104.19	022.20	093.64
274	80	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000.12	000.47
276	81	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	000.58	002.17

TABLE 12

RESULTS OF ANALYSIS OF THE 8 HOUR TWA CHARCOAL TUBE AIR SAMPLES

CHARCOAL TUBE SAMPLE ANALYSIS

EIGHT HOUR TWA SAMPLES

MILL CREEK WASTEWATER TREATMENT PLANT

SPL	ID	P	CTRI	CBZ	CTCE	CPCE	CTOL	CTPM	CTMGM	CZPPM	CZMGM
298	01	1	2.10	0.00	0.00	0.00	0.00	2.10	11.34	0002.59	0000.59
299	03	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0004.85	0001.29
300	06	1	3.44	0.20	0.20	0.15	0.11	4.10	31.25	0003.32	0000.88
301	11	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
302	19	1	0.00	0.08	0.00	0.00	0.00	0.08	00.25	0002.98	0000.79
303	27	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
304	34	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

MUDDY CREEK WASTEWATER TREATMENT PLANT

SPL	ID	P	CTRI	CBZ	CTCE	CPCE	CTOL	CTPM	CTMGM	CZPPM	CZMGM
305	41	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
306	45	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
307	49	1	0.00	5.45	0.00	0.28	0.00	5.73	19.27	4120.28	1093.43
308	52	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0049.45	0013.13

LITTLE MIAMI WASTEWATER TREATMENT PLANT

SPL	ID	P	CTRI	CBZ	CTCE	CPCE	CTOL	CTPM	CTMGM	CZPPM	CZMGM
309	60	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0028.71	0007.62
310	52	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0018.70	0004.96
311	65	1	0.00	0.40	0.00	3.76	0.00	4.16	26.50	0031.09	0008.25
312	69	1	0.00	0.00	0.00	0.35	0.00	0.38	02.55	0022.19	0005.89
314	73	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0002.02	0000.53
315	77	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0001.89	0000.50
316	82	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0007.95	0002.11

TABLE 13

RESULTS OF ANALYSIS OF CHARCOAL TUBE AIR SAMPLES COLLECTED AT OTHER SITES*

CHARCOAL TUBE SAMPLE ANALYSIS

SAMPLES COLLECTED AT OTHER SITES AND TIMES

MILL CREEK WASTEWATER TREATMENT PLANT

SPL	ID	P	CTRIC	CBENZ	CTCE	CPCE	CTOL	CCLBZ	CMEK	CMIBK	CXYL	CTPPMCTNGM	CZPPM	CZNGM	NOTE
026	05	1	04.34	01.45	0.00	0.00	02.02	0.00	0.00	13.11	01.08	07.81050.10	012.15	0045.78	1
044	03	1	48.55	0.00	0.00	01.21	00.45	0.00	0.00	0.00	00.01	50.22275.20	285.45	1075.60	2
047	09	1	01.17	00.49	02.69	02.22	01.54	0.00	0.00	0.00	00.01	09.11043.24	004.39	0016.56	1
074	16	1	03.85	01.28	00.33	00.67	00.05	0.00	14.82	0.00	00.19	06.18046.51	003.90	0014.69	3
081	20	1	02.21	00.20	00.30	00.47	00.20	0.00	02.26	0.00	0.00	03.38020.45	001.15	0004.33	3
101	29	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00 0.00	0.00	0.00	3
105	36	1	0.00	0.00	0.00	0.00	00.03	0.00	0.00	0.00	0.00	00.03000.12	000.07	0000.26	3

MUDDY CREEK WASTEWATER TREATMENT PLANT

SPL	ID	P	CTRIC	CBENZ	CTCE	CPCE	CTOL	CCLBZ	CMEK	CMIBK	CXYL	CTPPMCTNGM	CZPPM	CZNGM	NOTE
195	57	1	0.00	01.21	02.35	13.87	0.00	0.00	0.00	02.34	0.00	17.43112.93	007.45	0028.07	1

LITTLE MIAMI WASTEWATER TREATMENT PLANT

SPL	ID	P	CTRIC	CBENZ	CTCE	CPCE	CTOL	CCLBZ	CMEK	CMIBK	CXYL	CTPPMCTNGM	CZPPM	CZNGM	NOTE
233	58	1	0.00	05.15	30.75	74.95	0.00	0.00	25.15	0.00	0.00	110.85716.32	043.17	0162.57	1
248	72	1	02.63	00.20	0.00	00.75	00.18	0.00	04.35	0.00	0.00	03.76025.07	002.55	0009.66	4
256	75	1	0.00	03.52	14.42	30.54	0.00	0.00	0.00	0.00	0.00	48.49295.87	019.50	0073.84	5
277	79	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00 0.00	001.78	0006.71	4

*See Key for Table 11 for identity of other sites (as shown in NOTE)

TABLE 14

PEARSON CORRELATIONS COMPARING CENTURY OVA (ppm) VALUES WITH RESULTS OF THE CHARCOAL TUBE SAMPLE ANALYSES

	Mill Creek	Muddy Creek	Little Miami
CTPPM	-0.01332 **	0.51508 *	0.43555 *
CZPPM	-0.06622 *	0.55275 *	0.71340 **
CMIBK	0.72766 ****	0.48269 *	--
CMEK	-0.15495 *	0.25675 *	0.47584 *
CCIBZ	0.69740 ****	--	--
CXYL	0.04805 *	--	--
CTOL	0.82820 ****	0.15315 *	0.46201 *
CPCE	-0.17561 *	0.51317 *	0.55370 **
CTCE	0.04685 *	0.45159 *	0.72932 **
CBENZ	0.65416 ***	0.34900 *	0.70012 **
CTRIC	-0.14456 *	--	-0.17869 *

* P<1.0
** P<0.10
*** P<0.01
**** P<0.001

TABLE 15

THREE DIFFERENT TYPES OF CORRELATIONS COMPARING CENTURY OVA DATA (ppm) WITH CHARCOAL TUBE SAMPLE ANALYSES AT THE MILL CREEK PLANT

	Pearson	Spearman	Kendall
CTPPM	-0.01332 *	0.30326 *	--
CZPPM	-0.06622 *	0.43050 **	--
CMIBK	0.72766 ****	0.60235 ***	0.52138 ***
CMEK	-0.15495 *	-0.1949 *	-0.15401 *
CCIBZ	0.69740 ****	0.61197 ***	0.52430 ***
CXYL	0.04805 *	-0.12022 *	-0.11698 *
CTOL	0.82820 ****	0.65145 ***	0.52074 ***
CPCE	-0.7561 *	-0.29630 *	-0.22167 *
CTCE	0.04685 *	0.03763 *	0.03650 *
CBENZ	0.65416 ***	0.60785 ***	0.50017 ***
CTRIC	-0.14456 *	-0.07903 *	-0.06267 *

* P<1.0
** P<0.10
*** P<0.01
**** P<0.001

TABLE 16

RESULTS OF ANALYSIS OF CHLORINATED ORGANIC COMPOUNDS (HALOCARBONS) IN WATER SAMPLES COLLECTED DURING PEAK EPISODES OBSERVED ON THE CENTURY OVA

TABLE 16.0

Key For Tables 16.1-16.3

Spl	=	Sample Number
ID	=	Internal ID Number
P	=	Phase, 1 = Air, 2 = Water
WMeCL	=	Methylene Chloride
WChloR	=	Chloroform
WTric	=	1,1,1-Trichlcroethane
WB2C	=	Dibromochloromethane
WTCE	=	Trichloroethylene
WBC2	=	Bromodichloromethane
WPCE	=	Perchloroethylene
WTCUGL	=	Total Chlorinated Compounds in UG/L
WTA+C	=	Total Chlorinated + Aromatic Compounds - UG/L
WTAC-Bz	=	Total Chlorinated + Aromatic Minus 1,2,4-Trichlorobenzene

TABLE 16.1

RESULTS OF ANALYSIS OF CHLORINATED ORGANIC COMPOUNDS (HALOCARBONS)

IN WATER SAMPLES COLLECTED DURING PEAK EPISODES OBSERVED ON THE CENTURY OVA

WATER SAMPLE ANALYSIS FOR CHLORINATED ORGANIC COMPOUNDS

Results Expressed in µg/L (~PBB)

MILL CREEK WASTEWATER TREATMENT PLANT

SPL	ID	P	WMECL	WCLOR	WTRIC	WB2C	WTCE	WLC2	WPCE	WTCUGL	WTA+C	WTAC-BZ
016	01	2	021.11	10.94	017.10	03.62	01.57	1.44	001.94	060.30	0296.40	0296.40
030	02	2	035.55	03.17	134.05	0.00	03.37	0.0	010.43	136.57	1596.29	0771.21
037	03	2	0.000	02.22	023.94	00.14	00.61	0.0	002.86	029.77	0606.85	0211.45
049	04	2	093.61	0.00	014.55	0.00	07.50	0.0	046.73	162.54	1253.69	0441.95
057	05	2	0.000	00.47	012.97	0.00	00.43	0.0	016.36	030.23	1110.72	0301.98
062	06	2	0.000	0.00	066.47	0.00	0.00	0.0	004.11	090.58	0750.93	0427.64
071	07	2	488.37	08.41	070.53	0.00	03.85	0.24	007.59	579.05	0975.95	0874.97
073	08	2	005.63	0.00	003.13	25.12	0.00	0.0	010.51	044.38	0205.79	0107.33
082	09	2	0.000	0.00	041.98	00.13	00.41	0.0	004.97	047.79	0654.79	0490.58
087	10	2	0.000	00.32	075.04	00.15	01.70	0.13	004.17	082.52	0763.05	0376.55
091	11	2	0.000	0.00	0.000	0.00	0.00	0.0	0.000	0.000	1377.68	1377.68
094	12	2	160.57	09.81	429.45	0.00	00.23	0.0	003.69	611.75	2002.46	2002.46
094	13	2	334.13	07.44	209.63	0.00	03.40	3.20	003.09	558.01	1745.83	1055.69
099	14	2	022.96	0.00	000.92	0.00	11.31	0.0	001.27	035.46	1703.02	1234.16
104	15	2	0.000	00.47	016.45	0.00	01.04	0.0	009.02	026.97	0854.25	0087.70
112	16	2	003.93	00.70	018.20	0.00	00.51	0.0	000.50	024.09	1818.90	0326.49
116	17	2	005.27	01.15	013.00	00.72	05.72	0.0	014.54	040.48	1880.96	0224.82
121	18	2	000.08	00.14	0.000	0.00	0.00	0.0	0.000	000.22	1188.73	0143.89
127	19	2	0.000	00.40	002.37	0.00	00.31	0.0	001.09	004.17	1843.52	0013.78

TABLE 16.2

RESULTS OF ANALYSIS OF CHLORINATED ORGANIC COMPOUNDS (HALOCARBONS)

IN WATER SAMPLES COLLECTED DURING PEAK EPISODES OBSERVED ON THE CENTURY OVA

WATER SAMPLE ANALYSIS FOR CHLORINATED ORGANIC COMPOUNDS
Results Expressed in μg/L

MUDDY CREEK WASTEWATER TREATMENT PLANT

SPL	ID	P	WMECL	WCLOR	WTRIC	WB2C	WTCE	WBC2	WPCE	WTCUGL	WTA+C	WTAC-BZ
132	20	2	0.000	01.02	004.00	0.00	00.47	0.0	001.41	006.90	1162.19	0361.44
138	21	2	001.43	00.47	000.19	0.00	00.16	0.0	002.54	004.79	0005.25	0005.25
140	22	2	012.75	00.48	000.18	00.13	00.11	0.12	000.30	014.08	0022.75	0022.75
143	23	2	001.82	0.00	0.000	0.00	0.00	0.0	010.24	012.05	0014.36	0014.35
157	24	2	0.000	0.00	0.000	0.00	0.00	0.0	0.000	0.000	0003.75	0003.75
176	25	2	010.90	0.00	0.000	0.00	00.16	0.0	041.94	053.00	0062.52	0062.03
186	26	2	0.000	0.00	000.18	0.00	0.00	0.0	000.68	000.86	0051.97	0051.54
191	27	2	0.000	0.00	0.000	0.00	0.00	0.0	000.48	000.48	0224.29	0212.00
193	28	2	002.05	00.24	0.000	0.00	0.00	0.0	001.51	003.81	0486.31	0490.12

TABLE 16.3

RESULTS OF ANALYSIS OF CHLORINATED ORGANIC COMPOUNDS (HALOCARBONS)

IN WATER SAMPLES COLLECTED DURING PEAK EPISODES OBSERVED ON THE CENTURY OVA

WATER SAMPLE ANALYSIS FOR CHLORINATED ORGANIC COMPOUNDS

LITTLE MIAMI WASTEWATER TREATMENT PLANT

SPL	ID	P	WMECL	WCLOR	WTRIC	WB2C	WTCE	WBC2	WPCE	WTCUGL	WTA+C	WTAC-BZ
203	29	2	006.02	04.45	005.75	00.44	07.93	0.38	004.22	030.23	0108.68	0108.68
222	30	2	014.10	06.85	078.86	02.90	00.53	0.66	002.57	106.47	0365.96	0342.22
225	31	2	014.65	11.42	002.73	0.00	00.74	0.43	148.81	178.77	0661.09	0661.09
230	32	2	197.21	05.53	001.83	0.00	00.53	0.18	036.64	241.92	0491.62	0491.62
244	33	2	407.71	01.54	001.87	0.00	0.00	0.0	012.35	423.48	0518.91	0518.91
254	34	2	009.93	02.02	001.82	0.00	00.21	0.25	020.57	034.79	1398.78	1398.78
274	35	2	007.51	00.49	000.37	0.00	00.11	0.0	000.47	008.96	0108.68	0090.78
276	36	2	002.12	0.00	000.16	0.00	00.13	0.15	000.33	002.89	0032.70	0032.70
296	37	2	000.47	00.52	0.000	0.00	0.00	0.0	000.19	001.19	0034.15	0034.15

TABLE 17

RESULTS OF ANALYSIS FOR AROMATIC COMPOUNDS
IN WATER SAMPLES COLLECTED DURING PEAK
EPISODES OBSERVED ON THE CENTURY OVA

TABLE 17.0

Key For Tables 17.1-17.3

Spl	=	Sample Number
ID	=	Internal ID Number
P	=	Phase, 1 = Air, 2 = Water
WMEK	=	Methylethylketone
WBENZ	=	Benzene
WTOL	=	Toluene
WETBz	=	Ethylbenzene
Wxyl	=	Xylene
WCl_2Bz	=	Dichlorobenzene
WTCBz	=	1,2,4-Trichlorobenzene
WTAUGL	=	Total Aromatic Compounds in UG/L
WZAUGL	=	Total Aromatics Expressed as Toluene (UG/L)
WTA-Bz	=	Total Aromatics <u>Minus</u> 1,2,4-Trichlorobenzene (UG/L)

TABLE 17.1

RESULTS OF ANALYSIS FOR AROMATIC COMPOUNDS IN WATER SAMPLES

COLLECTED DURING PEAK EPISODES OBSERVED ON THE CENTURY OVA

Results Expressed in µg/L (~PBB)

WATER SAMPLE ANALYSIS FOR AROMATIC COMPOUNDS

MILL CREEK WASTEWATER TREATMENT PLANT

SPL	ID	P	WMEK	WBENZ	WTOL	WETBZ	WXYL	WCL2BZ	WTCBZ	WTAUGL	WZAUGL	WTA-TCBZ
016	01	2	058.50	000.44	065.48	030.77	041.16	039.76	0.000	0236.10	0305.11	0236.10
030	02	2	033.40	000.33	083.19	049.21	149.16	259.34	824.89	1409.53	1129.00	0584.64
037	03	2	027.64	000.20	045.54	030.52	030.13	046.57	589.39	0777.08	0514.65	0181.69
049	04	2	145.02	000.34	064.07	011.17	023.61	035.19	821.75	1101.16	0627.23	0279.41
057	05	2	091.15	000.14	061.88	0.000	062.83	055.70	808.74	1080.44	0824.01	0271.70
062	06	2	025.59	000.08	030.13	0.000	063.97	217.29	323.29	0660.35	0795.82	0337.05
071	07	2	062.85	000.12	020.73	120.76	051.93	039.48	100.98	0396.90	0501.69	0295.92
073	08	2	012.77	0.000	0.000	0.000	001.90	048.28	098.46	0161.41	0187.42	0062.95
082	09	2	112.41	000.24	009.40	0.000	147.95	172.90	164.10	0507.00	0653.39	0442.89
087	10	2	108.28	000.18	029.26	0.000	095.47	059.84	391.50	0685.53	0685.19	0294.03
091	11	2	059.82	002.79	018.07	312.18	946.90	037.91	0.000	1377.68	1467.61	1377.68
094	12	2	028.32	0.000	0.000	0.000	458.02	904.37	0.000	1390.71	1273.85	1390.71
094	13	2	039.52	003.62	010.93	049.68	094.55	299.39	690.14	1187.82	0356.61	0497.68
099	14	2	036.51	002.89	066.14	0.000	138.03	355.30	1068.51	1667.35	1532.43	0598.85
104	15	2	0.000	000.95	005.07	007.06	013.34	034.31	766.57	0827.29	0476.22	0060.73
112	16	2	008.90	001.92	024.35	033.31	127.55	106.36	1492.41	1794.81	1057.31	0302.40
115	17	2	025.57	001.52	013.89	051.81	060.13	031.42	1656.14	1840.48	1121.80	0184.34
121	18	2	012.79	001.90	017.77	011.68	024.93	074.62	1044.34	1188.51	0710.07	0142.07
127	19	2	005.99	0.000	000.59	0.000	000.32	002.72	1829.74	1839.35	0876.76	0009.61

TABLE 17.2

RESULTS OF ANALYSIS FOR AROMATIC COMPOUNDS IN WATER SAMPLES

COLLECTED DURING PEAK EPISODES OBSERVED ON THE CENTURY OVA

Results Expressed in μg/L

WATER SAMPLE ANALYSIS FOR AROMATIC COMPOUNDS

MUDDY CREEK WASTEWATER TREATMENT PLANT

SPL	ID	P	WMEK	WBENZ	WTOL	WETBZ	WXYL	WCL2BZ	WTCBZ	WTAUCL	WZAUCL	WTA-TCBZ
132	20	2	016.71	002.43	043.23	0.000	059.72	232.45	800.75	1155.29	0792.57	0354.54
138	21	2	0.000	0.000	0.000	0.000	000.46	0.000	0.000	0000.46	0093.45	0000.46
140	22	2	0.000	0.000	0.000	004.35	001.40	002.92	0.000	0008.57	0032.10	0008.57
143	23	2	0.000	0.000	001.91	0.000	000.38	0.000	0.000	0002.30	0023.11	0002.30
157	24	2	0.000	0.000	002.27	0.000	001.48	0.000	0.000	0003.75	0036.11	0003.75
176	25	2	0.000	0.000	001.63	0.000	006.61	000.78	000.50	0009.52	0045.75	0009.03
185	26	2	003.32	0.000	027.32	0.000	000.77	019.27	000.43	0051.11	0066.18	0050.68
191	27	2	0.000	0.000	009.37	0.000	000.94	201.21	012.29	0223.82	0193.20	0211.52
193	28	2	0.000	0.000	009.79	207.33	077.95	111.24	0.000	0496.31	0597.01	0486.31

AD-A133 714 CHARACTERIZATION OF SELECTED VOLATILE ORGANICS IN WASTEWATER TREATMENT INFLUENTS(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH V S DUNOVANT SEP 83 2/2

UNCLASSIFIED AFIT/CI/NR-83-50T F/G 13/2 NL

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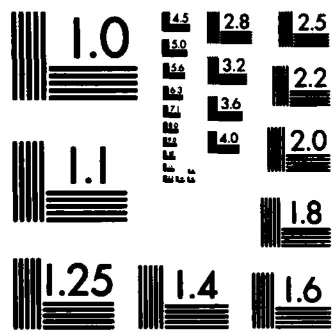

MICROCOPY RESOLUTION TEST CHART
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TABLE 17.3

RESULTS OF ANALYSIS FOR AROMATIC COMPOUNDS IN WATER SAMPLES

COLLECTED DURING PEAK EPISODES OBSERVED ON THE CENTURY OVA

Results Expressed in µg/L

WATER SAMPLE ANALYSIS FOR AROMATIC COMPOUNDS

LITTLE MIAMI WASTEWATER TREATMENT PLANT

SPL	ID	P	WMEK	WBENZ	WTOL	WETBZ	WXYL	WCL2BZ	WTCBZ	WTAUGL	WZAUGL	WIA-TCBZ
203	29	2	015.22	0.000	002.31	005.24	005.56	049.12	0.000	0078.45	0129.69	0078.45
222	30	2	046.18	0.000	015.67	020.35	041.14	112.41	023.74	0259.49	0339.22	0235.75
225	31	2	397.81	0.000	024.50	020.17	029.62	010.23	0.000	0482.32	0323.09	0492.32
230	32	2	040.72	0.000	002.29	035.22	074.55	095.93	0.000	0249.70	0315.41	0249.70
244	33	2	005.30	0.000	001.08	0.000	028.75	059.30	0.000	0095.43	0323.59	0095.43
254	34	2	1270.61	0.000	016.22	024.95	028.89	023.30	0.000	1363.99	0318.62	1363.99
274	35	2	025.58	0.000	005.27	0.000	003.41	047.54	017.91	0099.72	0160.93	0091.82
275	36	2	005.61	0.000	004.13	005.17	002.11	012.74	0.000	0029.81	0051.96	0029.81
296	37	2	003.75	0.000	003.36	0.000	001.63	024.21	0.000	0032.96	0060.38	0032.96

TABLE 18

PEARSON CORRELATIONS COMPARING CENTURY OVA (ppm) DATA WITH THE RESULTS OF SELECTED WATER SAMPLE ANALYSES

	Mill Creek	Muddy Creek	Little Miami
WTAUGL	0.30380 *	-0.19401 *	-0.36217 *
WZAUGL	-0.03651 *	-0.08413 *	0.35264 *
WTABZ	-0.19008 *	0.20491 *	-0.35578 *
WTCUGL	-0.06432 *	-0.39438 *	0.19329 *
WTAC	-0.12706 *	0.38305 *	0.06388 *
WTACBZ	-0.20787 *	0.17289 *	-0.28234 *
WTOL	-0.20331 *	-0.08843 *	-0.31353 *
WTCE	-0.11786 *	-0.55055 *	-0.37511 *

* P<1.0
** P<0.10
*** P<0.01
**** P<0.001

TABLE 19

COMPARISON OF AIR, WATER AND

CENTURY RESULTS

TABLE 19.1

COMPARISON OF AIR, WATER AND CENTURY RESULTS

MILL CREEK PLANT

AIR - PPM					WATER - µg/L (PPB)				
Spl #	CT'S PPM	CT'S PPM (Toluene)	Century PPM	CT Century =%	Spl #	Chlorinated	Aromatic	A+C	Total A (As Toluene)
5	7.806	12.15	100	8	2	186.57	1409.53	1596.28	1129.00
9	8.099	4.39	50	16	--	---	---	---	---
10	5.979	3.66	100	6	4	162.54	1101.16	1263.69	627.23
13	0.016		6	<1	5	30.28	1080.44	1110.72	824.01
14	0.819	0.20	30	2	6	90.58	660.35	750.93	795.88
15	1.331	0.93	60	2	7	579.05	396.90	975.95	501.69
17	4.841	10.54	50	10	8	44.38	161.41	205.79	187.42
21	1.533	0.66	100	2	9	47.79	607.00	654.79	663.39
22	1.871	0.78	50	4	10	82.52	685.53	768.05	685.19
23	5.089	2.28	100+	<5	11	---	1377.68	1377.68	1467.61
24	7.446	4.76	100+	<7	12	611.75	1390.71	2002.46	1273.85
30	6.026	4.99	100+	<6	15	26.87	827.29	854.26	476.22
31	1.344	0.71	100+	<1	16	24.09	1794.81	1818.90	1067.31
37	7.390	18.02	300	2	18	0.22	1188.51	1188.73	710.07
38	2.652	6.08	200	1	19	4.17	1839.35	1843.52	876.76

--- = None Detectable

TABLE 19.2

COMPARISON OF AIR, WATER AND CENTURY RESULTS

MUDDY CREEK PLANT

	AIR - PPM						WATER - µg/L (PPB)			
Spl #	CT'S PPM	PPM CT'S (Toluene)	Century PPM	CT Century =%	Spl #	Chlorinated	Aromatic	A+C	Total A (As Toluene)
43	0.097		70	<1	21	4.79	0.46	5.25	83.46
44	2.429	2.56	80	3	22	14.08	8.67	22.75	32.10
45	0.947	0.97	80	1	23	12.06	1.30	14.36	23.11
48	0.103	0.07	35	<1	24	---	3.75	3.75	36.11
51	2.281	2.02	40	6	25	53.00	9.52	65.52	45.75
54	30.072	11.57	100	11-30	26	0.86	51.11	51.97	68.18
55	1.911	1.70	100	2	27	0.48	223.82	224.29	193.22
56	23.645	9.43	100	10-23	28	3.81	486.31	490.11	597.01
57	17.433	7.45	60-100	7-17	28	3.81	486.31	490.11	587.01

--- = None Detectable

TABLE 19.3

COMPARISON OF AIR, WATER AND CENTURY RESULTS

LITTLE MIAMI PLANT

AIR - PPM					WATER - µg/L (PPB)				
Spl #	CT'S PPM	PPM CT'S (Toluene)	Century PPM	CT Century =%	Spl #	Chlorinated	Aromatic	A+C	Total A (As Toluene)
64	0.692	0.49	20	5	30	106.47	259.49	365.96	339.22
67	65.931	61.89	80	81	32	241.92	249.70	491.62	615.41
68	110.858	43.17	80	50-100	--	---	---	---	---
71	0.299	1.16	30	1	33	423.48	95.43	518.91	323.59
80	---	0.12	80	<1	35	8.96	99.72	108.68	160.93
81	---	0.58	100	<1	36	2.89	29.81	32.70	61.96

--- = None Detectable

TABLE 20

SUMMARY OF AIR AND WATER DATA

TABLE 20.0

Key For Tables 20.1-20.3

cis 12 Dichloroethylene

CCl_4 ND in water

ClBz

*124 TCBz values are not quantitative due to improper method thus interference from phthalates and other base/neutral compounds

-These compounds not found in air (charcoal samples) due to high chlorination and low affinity for charcoal

Xylenes - Total of ortho, meta and para isomers

Cl_2Bz - Total of ortho, meta and para isomers

Waters

Carbon Tetrachloride and cis-1,2-Dichloroethylene were not detected in any spls (ND<0.1)

Charcoal tubes were also ND<.01 for Freons (113, 13, 112, 12, 21)

C-1,2-Dichloroethylene

1,2-Dichloroethane

1,1-Dichloroethane

Ethyl Benzene

ND - None Detected (below detection limits)

TABLE 20.1

STATISTICAL SUMMARY OF AIR AND WATER DATA

MILL CREEK PLANT

	WATER µg/L				AIR mg/m^3			
	Range	Mean	Median	Freq %	Range	Mean	Median	Freq %
111 Trich	<.1-429	61.63	17.10	89	<.01-23.7	6.36	5.69	75
MEK	<.1-145	47.11	33.40	95	<.01-64.0	4.90	<.01	27
Benzene	<.1- 3.6	0.93	0.33	84	<.01- 5.8	1.65	1.42	87
Trichloroethylene	<.1- 11.3	2.22	0.61	79	<.01-18.4	3.48	<.01	40
PCE	<.1- 46.8	7.53	4.11	89	<.01-32.8	4.99	0.51	67
Toluene	<.1- 83.1	29.87	20.78	89	<.01-15.2	2.95	1.14	94
Xylene	0.3-946	133.31	62.83	100	<.01- 1.4	0.20	0.01	53
ClBz	---	---	---	--	<.01- 8.0	1.35	<.01	27
MIBK	---	---	---	--	<.01-13.3	2.38	<.01	33
Century					6-300	96.4	---	100
EtBz	<.1-3.12	37.27	11.2	58				
- Cl_2Bz	2.7-904	148.99	55.7	100				
-*124 TCBz	<.1-1829	666.92	690.1	84				
-MeCl	<.1-488.4	62.06	3.9	63				
_Chloroform	<.1- 10.9	2.40	0.5	68				
1,2-DCE	<.1- 2.7	0.15	<0.1	11				
-$BrCl_2CH$	<.1- 25.1	1.57	<0.1	37				
-Br_2ClCH	<.1- 1.4	0.11	<0.1	21				

TABLE 20.2

STATISTICAL SUMMARY OF AIR AND WATER DATA

MUDDY CREEK PLANT

	WATER µg/L				AIR mg/m^3			
	Range	Mean	Median	Freq %	Range	Mean	Median	Freq %
111 Trich	<.1- 4.0	0.51	<.1	44	<.01	<.01	<.01	0
MEK	<.1-16.7	2.22	<.1	22	<.01- 5.3	---	<.01	11
Benzene	<.1- 2.4	0.27	<.1	11	0.04- 6.4	2.33	0.94	100
Trichloroethylene	<.1- 0.5	0.10	<.1	44	<.01- 44.8	10.01	<.01	33
PCE	<.1-41.9	6.57	1.40	88	<.01-133.8	29.33	8.31	56
Toluene	<.1-43.2	10.61	2.27	78	<.01- 8.1	1.45	0.34	56
Xylene	0.4-77.9	16.64	1.40	100	<.01	<.01	<.01	0
ClBz	---	---	---	---	<.01	<.01	<.01	0
MIBK	---	---	---	---	<.01- 2.3	0.49	<.01	22
Century					35-100	65	---	100
EtBz	<.1-287.3	32.41	<.1	22				
-Cl_2Bz	<.1-232.4	63.10	2.92	67				
-•124 TCBz	<.1-100.7	90.44	<.1	44				
- MeCl	<.1- 12.7	3.06	<.1	44				
-Chloroform	<.1- 1.0	2.46	<.1	56				
1,2-DCE	<.1	<.1	<.1	0				
-$BrCl_2CH$	<.1- 0.13	---	<.1	11				
-Br_2ClCH	<.1- 0.12	---	<.1	11				

TABLE 20.3

STATISTICAL SUMMARY OF AIR AND WATER DATA

LITTLE MIAMI PLANT

	WATER µg/L				AIR mg/m^3			
	Range	Mean	Median	Freq %	Range	Mean	Median	Freq %
111 Trich	0.16- 78.9	10.48	1.83	100	<.01- 14.4	1.81	<.01	20
MEK	3.7 -1270	201.42	25.58	100	<.01- 26.2	3.31	<.01	30
Benzene	<.1	<.1	<.1	0	<.01- 0.6	0.09	<.01	20
Trichloroethylene	<.1- 7.9	1.14	0.21	78	<.01-189.5	49.12	<.01	40
PCE	0.2-148.8	25.10	4.22	100	<.01-508.4	86.17	3.27	60
Toluene	1.0- 24.5	8.32	4.18	100	<.01- 20.6	2.93	<.01	30
Xylene	1.6- 74-5	23.96	28.76	100	<.01- 2.6	0.56	<.01	30
ClBz	---	---	---	---	<.01	<.01	<.01	0
MIBK	---	---	---	---	<.01	<.01	<.01	0
Century					10-90	40	---	100
EtBz	<.1- 36.2	12.45	5.24	67				
- Cl_2Bz	10.2-112.4	48.31	47.55	100				
- 124 TCBz	<.1- 23.7	4.63	<.1	22				
MeCl	0.4-407.7	73.30	9.93	100				
- Chloroform	<.1- 11.4	3.65	2.01	89				
1,2-DCE	<.1	<.1	<.1	0				
- $BrCl_2CH$	<.1- 2.9	0.37	<.1	22				
- Br_2ClCH	<.1- 0.67	0.23	0.18	67				

TABLE 21

COMPARISON OF CHARCOAL TUBE SAMPLE

RESULTS TO CENTURY OVA READINGS

TABLE 21.0

COMPARISON OF CHARCOAL TUBE SAMPLE RESULTS
TO CENTURY OVA READINGS

MILL CREEK

Spl #	Tot. Indiv. Compounds	Tot. Indiv. Compounds*	Tot. Area*	PPM Century Value*
5	7.806	11.68	12.15	100
9	8.099	4.04	4.39	50
10	5.979	3.41	3.66	100
13	0.016	0.015	0.015	6
14	0.819	0.20	0.20	30
15	1.331	1.01	1.01	60
17	4.841	10.79	10.79	50
21	1.533	0.66	0.66	100
22	1.871	0.74	0.78	50
23	5.089	2.17	2.28	100+
24	7.446	4.66	4.76	100+
30	6.026	4.96	4.99	100+
31	1.344	0.70	0.71	100+
37	7.390	12.07	18.02	300
38	2.652	4.46	6.08	200

*Expressed as Toluene

TABLE 21.1

COMPARISON OF CHARCOAL TUBE SAMPLE RESULTS
TO CENTURY OVA READINGS

MUDDY CREEK

Spl #	Tot. Indiv. Compounds	Tot. Indiv. Compounds*	Tot. Area*	PPM Century Value*
43	0.097	0.09	0.09	70
44	2.429	2.43	2.56	80
45	0.947	0.94	0.97	80
48	0.103	0.07	0.07	35
51	2.281	1.45	2.02	40
54	30.072	10.03	11.57	100
55	1.911	1.53	1.70	100
56	23.645	7.01	9.43	100
57	17.433	6.90	7.45	60-100

*Expressed as Toluene

TABLE 21.2

COMPARISON OF CHARCOAL TUBE SAMPLE RESULTS
TO CENTURY OVA READINGS

LITTLE MIAMI

Spl #	Tot. Indiv. Compounds	Tot. Indiv. Compounds*	Tot. Area*	PPM Century Value*
64	0.692	0.24	0.49	20
67	65.931	31.95	61.89	80
68	110.858	41.66	43.17	80
71	0.299	1.05	1.16	30
80	---	---	0.12	80
81	---	---	0.58	100

*Expressed as Toluene

TABLE 22

TLV'S

Compound	TLV**	STEL***
MEK	200	300
Benzene*	10	25
Toluene	100	150
Ethyl Bz	100	125
Xylenes (omp)	100	150
Chloro Bz	75	-
Dichloro Bz (omp)	75	110
1,2,4-Cl_3Bz (TCBZ)	5	-
Methylene Chloride	100	500
Freon	1000	-
1,1-Dichloroethane	200	250
1,2-Dichloroethane	10	15
1,1,1-Trichloroethane	350	450
1,1,2-Trichloroethane	10	20
Carbon Tetrachloride*	5	20
Trichloroethylene*	50	150
Perchloroethylene	50	-
1,1,2,2 Tetrachloroethane	1	5
$BrClCH_2$	200	250
Br_2ClCH	-	-
$BrCl_2CH$	-	-
Bromoform	0.5	-
Chloroform*	10	50
Range	0.5 - 1000	5 - 500

*Suspect Carcinogens

**TLV - Treshold Limit Values, American Conference of Government Industrial Hygienists (ACGIH)

***STEL- Short Term Exposure Levels (ACGIH)

TABLE 23

TLV'S AND S.J. TOOGOOD, J.A. HOBSON VALUES (BRITISH PAPER)

	MW	PPM TLV	PPM STEL	Vapor Press mm Hg 25°	Vapor Press mm Hg 40°	Limiting Activity Coefficient 25°	Limiting Activity Coefficient 40°	TLV PPM/VOL	C_{TLV} mg/L
HEX	72	200	300	90.6	177.4	29.8	36.0	200	225 /95
◆*Bz	78	10	25	95.19	182.86	2.3 $\times 10^3$	2.2 $\times 1$ ^{3}	10	0.15 /0.08
Toluene	92	100	150	28.46	58.18	6.7 $\times 10^3$	6.9 $\times 10^3$	100	2.0 /0.95
EtBz	106	100	125	9.51	21.54	3.5 $\times 10^4$	3.3 $\times 10^4$	100	1.3 /0.63
Xyl (o,m,p)	106	100	150	8.73	19.04	3.1 $\times 10^4$	2.5 $\times 10^4$	100	1.7 /0.91
ClBz	112.6	75	---	12.09	26.52	1.5 $\times 10^4$	1.0 $\times 10^4$	75	2.0 /1.3
Cl_2Bz (o,m,p)	147	o 50 p 75	p 100	1.28	3.35	5.5 $\times 10^4$	4.3 $\times 10^4$	50	4.4 /2.2
1,2,4-TCBz	181	5	---						
MeCl	84.9	100	500	417	739	275	200	200	6.3 /2.5
Freon 12	121	1000	---						
1,1-$Cl_2C_2H_4$	9.9	200	250	200.7	369.7	700	---	---	1.5 /(0.81)
1,2-$Cl_2C_2H_4$	99	10	15	318.1	561.7	860	---	50	0.76 /(0.43)
111 Trich	133	350	450	124.75	232.52	6.4 $\times 10^3$	6.7 $\times 10^3$	350	2.5 /1.3
112 Trich	133	10	20	24.03	50.17	1.67$\times 10^3$	1.86$\times 10^6$	10	1.4 /0.72
*CCl_4	154	5	20	114.2	213.7	1.1 $\times 10^4$	---	10	0.052/(0.02)
TCE	131.4	50	150	70.59	138.70	6.6 $\times 10^3$	---	100	1.2 /(0.09)
PCE	165.9	50	---	18.20	89.11	6.1 $\times 10^4$	---	100	0.63 /(0.29)
1122 $Cl_4C_2H_2$	168	1	5					1	
$BrClCH_2$	129	200	250					200	
Br_2ClCH	208	---	---					---	
$BrCl_2CH$	164	---	---					---	
Bromoform	253	0.5	---					0.5	
*Chloroform	119.4	10	50	194.99	360.4	781	765	10	0.33 /0.18

Range 0.5-1000 5-500

*Suspect Carcinogens

◆Discharge prohibited by law (petroleum spirit-low flash pt.)

TABLE 24

SUMMARY TABLE OF C_{TLV}'S AND RAT'S

	% C_{TLV}	C_{TLV}	Range
McCl	< 7%	6.3 mg/L	ND-0.488 mg/L
Chloroform	< 3%	0.33	ND-0.011
1,2 DCE	< 0.4%	0.76	ND-0.003
111 Trich	<17%	2.50	ND-0.429
CCl_4	---	0.052	ND
$BrCl_2CH$	---	---	ND-0.025
TCE	< 0.9%	1.20	ND-0.011
BR_2ClCH	---	---	ND-0.001
PCE	<23%	0.63	ND-0.148
MEK	< 0.5%	2.25	ND-1.270
Bz	< 2%	0.15	ND-0.004
Tol	< 4%	2.00	ND-0.083
EtBz	<24%	1.30	ND-0.312
Xyl (o,m,p)	<55%	1.70	ND-0.947
ClBz	---	2.00	---
Cl_2Bz (o,m,p)	<20%	4.40	ND-0.904
1,2,3 TCBz	---	---	ND-1.829

*ND=None Detected (below detection limits)

	>RAT	25-100%	10-25%	5-10%	0-5%
Mill Creek	---	---	---	5	8
Muddy Creek	---	---	---	---	2
Little Miami	---	---	---	---	3
mg/L	>26.22	13.1-26.2	2.6-1.31	1.31-2.62	.26-13

RAT = Relative Atmospheric Toxicity*

$$RAT = \Sigma \frac{Ci}{C_{TLV}} = 2.622 \text{ mg/L}$$ (excludes MEK)

*Based on Toogood and Hobson (14)

TABLE 25

A SUMMARY OF THE STATISTICS PERFORMED COMPARING ANALYTICAL RESULTS FROM AIR AND WATER SAMPLES

	Variables			
Procedure	Dependent	Independent	By	Results
REGRESSION	PPM	PLANT	PLT	NS
ANOVA	PPM	PLANT	PLT	NS
GLM	PPM	PLANT	PLT	NS
GLM	PPM	PLT	PLT	NS
GLM		FLO	PLT	NS
GLM		PLT-FLO	PLT	NS
REG	PPM	PLT	PLT	NS
REG	CZPPM	PPM	PLT	NS
REG	WTAC	PPM	PLT	NS
REG	WTAUGL	PPM	PLT	NS
REG	WZAUGL	PPM	PLT	NS
REG	WTABZ	PPM	PLT	NS
REG	WTCUBL	PPM	PLT	NS
REG	WTACBZ	PPM	PLT	NS
REG	WTACBZ	CTPPM	PLT	NS
NPAR1WAY	CTPPM	PLT		NS
NPAR1WAY	CTPPM	PLT		NS
NPAR1WAY	CTOL	PLT		NS
NPAR1WAY	CTCE	PLT		NS
NPAR1WAY	CMIBK	PLT		NS
NPAR1WAY	CBENZ	PLT		NS
GLM	PPM	AMPM		NS
GLM	PPM	PLT		NS
GLM	PPM	DAY		NS
GLM	PPM	WEEKDAY/WEEKEND		NS
GLM		PLT		NS
GLM		DAY		NS

TABLE 26

SUMMARY OF THE NUMBER AND MAGNITURE OF THE HIGHEST READINGS ON THE CENTURY OVA (PPM)

MILL CREEK PLANT

Time Periods	Number of Readings in Specified Ranges During Indicated Time Period			#30 Min Time Intervals
	0-49	50-99	≥100	
0900-1359	24	19	5	48
1400-1900	23	28	16	67

LITTLE MIAMI PLANT

	0-49	50-99	>100	
0900-1359	46	2	0	48
1400-1900	40	12	0	52

MUDDY CREEK PLANT

	0-49	50-99	>100	
0900-1359	30	4	1	35
1400-1900	20	9	4	33

APPENDIX 1

COMPUTER METHODS AND SEQUENCES FOR CHARCOAL TUBE SAMPLE ANALYSIS

APPENDIX 1.1

COMPUTER METHOD USED FOR CHARCOAL TUBE SAMPLE ANALYSES

```
SEP 15, 1982    0:19
METHOD: ZR09
CHANNEL  9

1. DATA INPUT

 RUNTM   #PKS
  15.00,   35

 MV/MIN   DELAY   MIN-AR   BUNCH
   .300,   0.00,    100,   AUTO

 INTEGRATOR EVENTS
     TIME   EVENT
  1   /E

 CONTROL EVENTS
     TIME   EVENT  ECM  RLY
  1   /E

2. DATA ANALYSIS

 PROC  RPRT  BUP-UNK
 ZERO,  LO,   NO

 UNITS   TITLE
 MG

3. USER PROGRAMS

 POST-ANAL  DIALG-PRG  PARAM-FILE
 /N

4. REPORTS

        RDVC #RPTS
   1    14,   1
   2    /E
```

APPENDIX 1.2

COMPUTER - AUTOSAMPLER SEQUENCE USED FOR CHARCOAL TUBE SAMPLE ANALYSES

```
SEP 15, 1982   22:47
SEQUENCE: ALS9
CHANNEL  9

SUBSEQUENCE  1

 METHOD
 ZR09

 DIALG-PRE  PARAM-FILE
 /N

 QUSMS  OPMPS  STOP
  3,     3,     1

 ISD  POST-STLO  POST-QUSMS
 YES,     1,          1

 SAMPLES
```

	SAMPLE-NAME	STLO	PROC-FILE	RAW-FILE	%DIL-F	STD-AMT	SMP-AMT
1	CS2	1,	P90001	R90001	100.00,	1.0000,	1.0000
2	STD1	2,	P90002	R90002	100.00,	1.0000,	1.0000
3	STD2	3,	P90003	R90003	100.00,	1.0000,	1.0000
4	STD3	4,	P90004	R90004	100.00,	1.0000,	1.0000
5	STD4	5,	P90005	R90005	100.00,	1.0000,	1.0000
6	SPL1	6,	P90006	R90006	100.00,	1.0000,	1.0000
7	SPL2	7,	P90007	R90007	100.00,	1.0000,	1.0000
8	SPL3	8,	P90008	R90008	100.00,	1.0000,	1.0000
9	SPL4	9,	P90009	R90009	100.00,	1.0000,	1.0000
10	SPL5	10,	P90010	R90010	100.00,	1.0000,	1.0000
11	SPL6	11,	P90011	R90011	100.00,	1.0000,	1.0000
12	SPL7	12,	P90012	R90012	100.00,	1.0000,	1.0000
13	SPL8	13,	P90013	R90013	100.00,	1.0000,	1.0000
14	SPL9	14,	P90014	R90014	100.00,	1.0000,	1.0000
15	SPL10	15,	P90015	R90015	100.00,	1.0000,	1.0000
16	STD5	16,	P90016	R90016	100.00,	1.0000,	1.0000
17	SPL11	17,	P90017	R90017	100.00,	1.0000,	1.0000
18	SPL12	18,	P90018	R90018	100.00,	1.0000,	1.0000
19	SPL13	19,	P90019	R90019	100.00,	1.0000,	1.0000
20	SPL14	20,	P90020	R90020	100.00,	1.0000,	1.0000
21	SPL15	21,	P90021	R90021	100.00,	1.0000,	1.0000
22	SPL16	22,	P90022	R90022	100.00,	1.0000,	1.0000
23	SPL17	23,	P90023	R90023	100.00,	1.0000,	1.0000
24	SPL18	24,	P90024	R90024	100.00,	1.0000,	1.0000
25	SPL19	25,	P90025	R90025	100.00,	1.0000,	1.0000
26	SPL20	26,	P90026	R90026	100.00,	1.0000,	1.0000
27	STD6	27,	P90027	R90027	100.00,	1.0000,	1.0000
28	SPL21	28,	P90028	R90028	100.00,	1.0000,	1.0000
29	SPL22	29,	P90029	R90029	100.00,	1.0000,	1.0000
30	SPL23	30,	P90030	R90030	100.00,	1.0000,	1.0000
31	SPL24	31,	P90031	R90031	100.00,	1.0000,	1.0000
32	SPL25	32,	P90032	R90032	100.00,	1.0000,	1.0000
33	SPL26	33,	P90033	R90033	100.00,	1.0000,	1.0000
34	SPL27	34,	P90034	R90034	100.00,	1.0000,	1.0000
35	SPL28	35,	P90035	R90035	100.00,	1.0000,	1.0000
36	SPL29	36,	P90036	R90036	100.00,	1.0000,	1.0000
37	SPL30	37,	P90037	R90037	100.00,	1.0000,	1.0000
38	STD7	38,	P90038	R90038	100.00,	1.0000,	1.0000
39	SPL31	39,	P90039	R90039	100.00,	1.0000,	1.0000
40	SPL32	40,	P90040	R90040	100.00,	1.0000,	1.0000
41	SPL33	41,	P90041	R90041	100.00,	1.0000,	1.0000
42	SPL34	42,	P90042	R90042	100.00,	1.0000,	1.0000
43	SPL35	43,	P90043	R90043	100.00,	1.0000,	1.0000
44	SPL36	44,	P90044	R90044	100.00,	1.0000,	1.0000
45	SPL37	45,	P90045	R90045	100.00,	1.0000,	1.0000
46	SPL38	46,	P90046	R90045	100.00,	1.0000,	1.0000
47	SPL39	47,	P90047	R90047	100.00,	1.0000,	1.0000
48	SPL40	48,	P90048	R90048	100.00,	1.0000,	1.0000
49	STD8	49,	P90049	R90049	100.00,	1.0000,	1.0000
50	/N	0,	SPRC09	SRAW09	100.00,	1.0000,	1.0000

APPENDIX 1.2 (continued)

COMPUTER - AUTOSAMPLER SEQUENCE USED FOR CHARCOAL TUBE SAMPLE ANALYSES

SUBSEQUENCE 2

METHOD
ZR09

DIALG-PRG PARAM-FILE
/N

QUSMS QPMPS STOP
3, 3, 1

ISO POST-BTL0 POST-QUSMS
YES, 50, 1

SAMPLES

	SAMPLE-NAME	BTL0	PROC-FILE	RAW-FILE	%DIL-F	STD-AMT	SMP-AMT
1	CS2	, 50,	P90050	, R90050	, 100.00,	1.0000,	1.0000
2	STD9	, 51,	P90051	, R90051	, 100.00,	1.0000,	1.0000
3	SPL41	, 52,	P90052	, R90052	, 100.00,	1.0000,	1.0000
4	SPL42	, 53,	P90053	, R90053	, 100.00,	1.0000,	1.0000
5	SPL43	, 54,	P90054	, R90054	, 100.00,	1.0000,	1.0000
6	SPL44	, 55,	P90055	, R90055	, 100.00,	1.0000,	1.0000
7	SPL45	, 56,	P90056	, R90056	, 100.00,	1.0000,	1.0000
8	SPL46	, 57,	P90057	, R90057	, 100.00,	1.0000,	1.0000
9	SPL47	, 58,	P90058	, R90058	, 100.00,	1.0000,	1.0000
10	SPL48	, 59,	P90059	, R90059	, 100.00,	1.0000,	1.0000
11	SPL49	, 60,	P90060	, R90060	, 1000.0,	1.0000,	1.0000
12	SPL50	, 61,	P90061	, R90061	, 100.00,	1.0000,	1.0000
13	STD10	, 62,	P90062	, R90062	, 100.00,	1.0000,	1.0000
14	SPL51	, 63,	P90063	, R90063	, 100.00,	1.0000,	1.0000
15	SPL52	, 64,	P90064	, R90064	, 100.00,	1.0000,	1.0000
16	SPL53	, 65,	P90065	, R90065	, 100.00,	1.0000,	1.0000
17	SPL54	, 66,	P90066	, R90066	, 100.00,	1.0000,	1.0000
18	SPL55	, 67,	P90067	, R90067	, 100.00,	1.0000,	1.0000
19	SPL56	, 68,	P90068	, R90068	, 100.00,	1.0000,	1.0000
20	SPL57	, 69,	P90069	, R90069	, 100.00,	1.0000,	1.0000
21	SPL58	, 70,	P90070	, R90070	, 100.00,	1.0000,	1.0000
22	SPL59	, 71,	P90071	, R90071	, 100.00,	1.0000,	1.0000
23	SPL60	, 72,	P90072	, R90072	, 100.00,	1.0000,	1.0000
24	STD11	, 73,	P90073	, R90073	, 100.00,	1.0000,	1.0000
25	SPL61	, 74,	P90074	, R90074	, 100.00,	1.0000,	1.0000
26	SPL62	, 75,	P90075	, R90075	, 100.00,	1.0000,	1.0000
27	SPL63	, 76,	P90076	, R90076	, 100.00,	1.0000,	1.0000
28	SPL64	, 77,	P90077	, R90077	, 100.00,	1.0000,	1.0000
29	SPL65	, 78,	P90078	, R90078	, 100.00,	1.0000,	1.0000
30	SPL66	, 79,	P90079	, R90079	, 100.00,	1.0000,	1.0000
31	SPL67	, 80,	P90080	, R90080	, 100.00,	1.0000,	1.0000
32	SPL68	, 81,	P90081	, R90081	, 100.00,	1.0000,	1.0000
33	SPL69	, 82,	P90082	, R90082	, 100.00,	1.0000,	1.0000
34	SPL70	, 83,	P90083	, R90083	, 100.00,	1.0000,	1.0000
35	STD12	, 84,	P90084	, R90084	, 100.00,	1.0000,	1.0000
36	SPL71	, 85,	P90085	, R90085	, 100.00,	1.0000,	1.0000
37	SPL72	, 86,	P90086	, R90086	, 100.00,	1.0000,	1.0000
38	SPL73	, 87,	P90087	, R90087	, 100.00,	1.0000,	1.0000
39	SPL74	, 88,	P90088	, R90088	, 100.00,	1.0000,	1.0000
40	SPL75	, 89,	P90089	, R90089	, 100.00,	1.0000,	1.0000
41	SPL76	, 90,	P90090	, R90090	, 100.00,	1.0000,	1.0000
42	SPL77	, 91,	P90091	, R90091	, 100.00,	1.0000,	1.0000
43	SPL78	, 92,	P90092	, R90092	, 100.00,	1.0000,	1.0000
44	SPL79	, 93,	P90093	, R90093	, 100.00,	1.0000,	1.0000
45	SPL80	, 94,	P90094	, R90094	, 100.00,	1.0000,	1.0000
46	STD13	, 95,	P90095	, R90095	, 100.00,	1.0000,	1.0000
47	SPL81	, 96,	P90096	, R90096	, 100.00,	1.0000,	1.0000
48	SPL82	, 97,	P90097	, R90097	, 100.00,	1.0000,	1.0000
49	SPL83	, 98,	P90098	, R90098	, 100.00,	1.0000,	1.0000
50	SPL84	, 99,	P90099	, R90099	, 100.00,	1.0000,	1.0000
51	/F						

APPENDIX 2

COMPUTER PROCEDURES FOR WATER ANALYSES FOR PURGEABLE HALOCARBONS

APPENDIX 2.1

COMPUTER METHOD USED FOR WATER ANALYSES FOR PURGEABLE HALOCARBONS

```
SEP 12, 1982   23:45
METHOD: PUR601:TO
CHANNEL 22

1. DATA INPUT

 RUNTM   #PKS
 30.00,   75

 MV-MIN   DELAY   MIN-AR   BUNCH
   .100,   .30,    5000,   ONCE

 INTEGRATOR EVENTS
    TIME   EVENT
 1   /E

 CONTROL EVENTS
    TIME   EVENT  ECM  RLY
 1   /E

2. DATA ANALYSIS

 PROC  RPRT  SUP-UNK
 ESTD,  EX,   NO

 UNITS   TITLE
 UG/L  , PURGEABLE HALOCARBONS

 REF-RTW  %RTW   RF-UNK      ID-LVL    DVT
    .10,  1.0, 1.0000E+ 0,     4950,   0.00

 CALIBRATION PEAKS
     TIME      AMOUNT          FACTOR        NAME
 1    7.34, 1.0000E- 1, 2.9695E- 7, &METHYLENE CHLORIDE
 2    8.90, 1.0000E+ 0, 1.0000E+ 0, &FREON-11
 3   10.50, 1.0000E+ 0, 1.0000E+ 0, &BROMOCHLOROMETHANE
 4   11.12, 1.0000E- 1, 1.0000E+ 0, &11-DICHLOROETHANE
 5   11.46, 1.0000E+ 0, 4.0601E- 6, &CIS-12-DICLETHYLENE
 6   12.02, 1.0000E+ 0, 1.0000E+ 0, &CHLOROFORM
 7   12.70, 1.0000E+ 0, 5.7750E- 5, &112FREON
 8   12.77, 1.0000E+ 0, 8.2793E- 6, &12-DICHLOROETHANE
 9   13.83, 1.0000E+ 0, 1.0000E+ 0, &EPICHLOROHYDRIN
10   14.08, 1.0000E+ 0, 5.0670E- 6, &111-TRICHLOROETHANE
11   14.45, 1.0000E+ 0, 4.1085E- 6, &CARBON TETRACHLORIDE
12   14.89, 1.0000E+ 0, 2.2631E- 6, &BROMODICHLOROMETHANE
13   16.85, 1.0000E+ 0, 1.7311E- 4, &12-DICHLOROPROPANE
14   17.15, 1.0000E+ 0, 3.6062E- 5, &TRICHLOROETHYLENE
15   17.70, 1.0000E+ 0, 1.6346E- 5, &DIBROMOCHLOROMETHANE
16   18.37, 1.0000E+ 0, 1.0000E+ 0, &112TRICHLOROETHANE
17   18.43, 1.0000E+ 0, 1.0000E+ 0, &CIS-13-DICHLOROPROPEN
18   19.75, 1.0000E+ 0, 2.9233E- 4, &1CHLORO2BROMOPROPANE
19   20.45, 1.0000E+ 0, 2.7495E- 6, &BROMOFORM
20   22.93, 1.0000E+ 0, 6.7853E- 6, &1122TETRACHLOROETHYLE
21   23.60, 1.0000E+ 0, 1.0000E+ 0, &1122TETRACHLOROETHANE
22   23.88, 1.0000E+ 0, 1.0000E+ 0, &14DICHLOROBUTANE
23   25.76, 1.0000E+ 0, 8.0658E- 6, &CHLOROBENZENE
24   /E

3. USER PROGRAMS

 POST-ANAL  DIALG-PRG  PARAM-FILE
 INFO2 :LP
```

APPENDIX 2.2

COMPUTER - AUTOSAMPLER SEQUENCE USED FOR WATER ANALYSES FOR PURGEABLE HALOCARBONS

```
SEP 10, 1982     9:42
SEQUENCE: SEQ220
CHANNEL 22

SUBSEQUENCE  1

 METHOD
 PUR601:TO

 FIELD-PRG  PARAM-FILE
  1.

 #WSHS  #PRMS  STOP
   3,     3,    1

 ISD  POST-BTL#  POST-#WSHS
 .ES.     1.          1

 SAMPLES
```

BK.	SAMPLE-NAME	BTL#	PROC-FILE	RAW-FILE	%DIL-F	STD-AMT	SMP-AMT
1	T1	1.	PA0001	RA0001	100.00	1.0000	1.0000
2	T2	2.	PA0002	RA0002	100.00	1.0000	1.0000
3	T3	3.	PA0003	RA0003	100.00	1.0000	1.0000
4	T4	4.	PA0004	RA0004	100.00	1.0000	1.0000
5	T5	5.	PA0005	RA0005	100.00	1.0000	1.0000
6	T6	6.	PA0006	RA0006	100.00	1.0000	1.0000
7	T7	7.	PA0007	RA0007	100.00	1.0000	1.0000
8	T8	8.	PA0008	RA0008	100.00	1.0000	1.0000
9	T9	9.	PA0009	RA0009	100.00	1.0000	1.0000
10	T10	10.	PA0010	RA0010	100.00	1.0000	1.0000
11	/EXIT/						

APPENDIX 3

COMPUTER PROCEDURES FOR WATER ANALYSES FOR PURGEABLE AROMATICS

APPENDIX 3.1

COMPUTER METHOD USED FOR WATER ANALYSES

FOR PURGEABLE AROMATICS

```
SEP 13, 1982   13:40
METHOD: PUR602:TO
CHANNEL 21

1. DATA INPUT

 RUNTM   #PKS
  30.00,  150

 PK-MIN   DELAY   MIN-AR   BUNCH
  .300,    .30,    1000,    ONCE

 INTEGRATOR EVENTS
     TIME   EVENT
  1   /E

 CONTROL EVENTS
     TIME   EVENT   ECM   RLY
  1   /E

2. DATA ANALYSIS

 PROC   RPRT   SUF-UNK
 ESTD,  EX,     NO

 UNITS   TITLE
 UG L  , PURGEABLE AROMATICS

 REF-RTW  %RTW   RF-UNK        ID-LVL     DVT
    ..0,   1.0, 1.0000E- 0,      950,    0.00

 CALIBRATION PEAKS
     TIME        AMOUNT          FACTOR       NAME
  1     3.00, 1.0000E+ 0, 1.3363E- 4, &MEI
  2     3.44, 5.0000E- 1, 8.0298E- 6, &BENZENE
  3     6.09, 1.0000E+ 0, 8.1168E- 5, &TOLUENE
  4     6.77, 1.0000E+ 0, 9.4973E- 6, &ETHYLBENZENE
  5     9.29, 1.0000E+ 0, 1.1201E- 5, &P-XYLENE
  6     9.54, 1.0000E+ 0, 8.1009E- 6, &M-XYLENE
  7    10.28, 1.0000E+ 0, 9 5986E- 6, &O-XYLENE
  8    11.29, 1.0000E+ 0, 8.4709E- 5, &CHLOROBENZENE
  9    17.61, 1.0000E+ 0, 1.0000E+ 0, &M-DICHLOROBENZENE
 10    18.38, 1.0000E+ 0, 1.0000E+ 0, O-DICHLOROBENZENE
 11    24.35, 1.0000E+ 0, 1.0000E+ 0, &P-DICHLOROBENZENE
 12   /E

3. USER PROGRAMS

 POST-ANAL  DIALG-PRG  PARAM-FILE
 INFOS ILE

4. REPORTS

     RDVC #RPTS
  1   L1,    1
  2   /E
```

APPENDIX 3.2

COMPUTER - AUTOSAMPLER SEQUENCE USED FOR WATER ANALYSES FOR PURGEABLE AROMATICS

```
SEP 30, 1982    9:50
SEQUENCE: SEQ21B
CHANNEL 21

SUBSEQUENCE  1

 METHOD
 PURG02:TO

 DIALC-PRG  PARAM-FILE
  NO

 #RUNS  #SMPS  STOP
   3.     3.    1

 USE  ST-BTL#  POST-RUNS
 YES.    1.         1

 SAMPLES
```

	SAMPLE-NAME		BTL#	PROC-FILE		RAW-FILE		%DIL-F	STD-AMT	SMP-AMT
1	T1	,	1.	PA0001	,	RA0001	,	100.00,	1.0000,	1.0000
2	T2	,	2.	PA0002	,	RA0002	,	100.00,	1.0000,	1.0000
3	T3	,	3.	PA0003	,	RA0003	,	100.00,	1.0000,	1.0000
4	T4	,	4.	PA0004	,	RA0004	,	100.00,	1.0000,	1.0000
5	T5	,	5.	PA0005	,	RA0005	,	100.00,	1.0000,	1.0000
6	T6	,	6.	PA0006	,	RA0006	,	100.00,	1.0000,	1.0000
7	T7	,	7.	PA0007	,	RA0007	,	100.00,	1.0000,	1.0000
8	T8	,	8.	PA0008	,	RA0008	,	100.00,	1.0000,	1.0000
9	T9	,	9.	PA0009	,	RA0009	,	100.00,	1.0000,	1.0000
10	T10	,	10.	PA0010	,	RA0010	,	100.00,	1.0000,	1.0000
11	E									

APPENDIX 4

COMPUTER STATISTICAL PROGRAMS

APPENDIX 4.1

SASRUN 1

```
//WENHI01A JOB (0,K348CH),'DUNOVANT SASRUN1',
// TIME=(0,30),REGION=250K,MSGLEVEL=(1,1)
/*ROUTE PRINT RMT3
// EXEC SAS795,REGION=250K
//DCENTGC DD DSN=WENHI01.DCENTGC,DISP=OLD,UNIT=SYSDA,VOL=SER=WRK151
//DWCL DD DSN=WENHI01.DWCL,DISP=OLD,UNIT=SYSDA,VOL=SER=WRK151
//DWARO DD DSN=WENHI01.DWARO,DISP=OLD,UNIT=SYSDA,VOL=SER=WRK151
//DACTPK DD DSN=WENHI01.DACTPK,DISP=OLD,UNIT=SYSDA,VOL=SER=WRK151
//DACTSP DD DSN=WENHI01.DACTSP,DISP=OLD,UNIT=SYSDA,VOL=SER=WRK151
//DACTDAY DD DSN=WENHI01.DACTDAY,DISP=OLD,UNIT=SYSDA,VOL=SER=WRK151
//WRITE DD UNIT=3380,DSN=WENHI01.SASRUN1,
// DISP=(NEW,CATLG),SPACE=(TRK,(5,5),RLSE),VOL=SER=M80116
//SAS.SYSIN DD *
DATA ONE;INFILE DCENTGC;
INPUT SPL 2-4 PLT 6 DAY 8 NO 10-11 DATE 12-13 TIME 15-18
PPM 20-22 MGM 24-26 FLO 28-30 RAIN 32 DET 34 COL 35
PH 38-40 AT 42-43 WT 45-46 HUM 48-49 SS 51-53 DS 55-57
CON 59-61 PO4 63-65 P 67;
DATA TWO;INFILE DWARO;
INPUT SPL 2-4 ID 6-7 P 9 WMEK 11-16 WBENZ 18-23 WTOL 25-30
WETBZ 32-37 WXYL 39-44 WCL2BZ 52-58 WTAUGL 60-66 WZAUGL 70-76
WTABZ 78-84;
DATA THREE;INFILE DWCL;
INPUT SPL 2-4 ID 5-7 P 9 WMECL 11-16 WCLOR 18-22 WTRIC 24-29
WB2C 31-35 WTCE 37-41 WBC2 43-46 WPCE 48-53 WTCUGL 55-61
WTZC 63-69 WTACBZ 71-77;
DATA FOUR;INFILE DACTPK;
INPUT SPL 2-4 ID 5-7 P 9 CTRIC 11-15 CBENZ 17-21 CTCE 23-27
CPCE 29-33 CTOL 35-39 CXYL 41-45 CCLBZ 47-51 CMEK 85-90
CMIBK 92-96 CTPPM 53-58 CTMGM 60-65 CZPPM 70-75 CZMGM 77-82;
DATA FIVE;INFILE DACTSP;
INPUT SPL 2-4 ID 5-7 P 9 CTRIC 11-15 CBENZ 17-21 CTCE 23-27
CPCE 29-33 CTOL 35-39 CCLBZ 41-45 CMEK 47-51 CMIBK 53-57
CXYL 59-63 CTPPM 65-69 CTMGM 70-75 CZPPM 77-82 CZMGM 84-90
NOTE 92;
DATA SIX;INFILE DACTDAY;
INPUT SPL 2-4 ID 5-7 P 9 CTRIC 11-14 CBENZ 16-19 CTCE 21-24
CPCE 26-29 CTOL 31-34 CTPPM 36-39 CTMGM 41-45 CZPPM 47-53
CZMGM 55-61;
PROC SORT DATA=ONE; BY SPL;
PROC SORT DATA=TWO;BY SPL;
PROC SORT DATA=THREE;BY SPL;
PROC SORT DATA=FOUR;BY SPL;
PROC SORT DATA=FIVE;BY SPL;
PROC SORT DATA=SIX;BY SPL;
DATA WRITE.ALL;
MERGE ONE TWO THREE FOUR FIVE SIX; BY SPL;
PROC PRINT DATA=WRITE.ALL;
```

APPENDIX 4.2

SASRUN 2

```
//WENHI011 JOB (0,K348CH),'DUNOVANT SASRUN2',
// TIME=(0,30),REGION=256K
/*ROUTE PRINT RMT3
// EXEC SAS79S
//WRITE DD UNIT=3380,VOL=SER=ME0116,
// DSN=WENHI01.SASRUN1,DISP=OLD,SPACE=(TRK,(5,5),RLSE)
//SAS.SYSIN DD *
DATA ONE;SET WRITE.ALL;
PROC SORT;BY PLT;
PROC CORR DATA=WRITE.ALL; VAR PPM; WITH DAY;
PROC CORR DATA=WRITE.ALL; VAR PPM; WITH TIME;
PROC CORR DATA=WRITE.ALL; VAR PPM; WITH FLO;
PROC CORR DATA=WRITE.ALL; VAR PPM; WITH RAIN;
PROC CORR DATA=WRITE.ALL; VAR PPM; WITH HUM;
PROC CORR DATA=WRITE.ALL; VAR PPM; WITH DET;
PROC CORR DATA=WRITE.ALL; VAR PPM; WITH COL;
PROC CORR DATA=WRITE.ALL; VAR PPM; WITH PH;
PROC CORR DATA=WRITE.ALL; VAR PPM; WITH WTAUGL;
PROC CORR DATA=WRITE.ALL; VAR PPM; WITH WTZAUGL;
PROC CORR DATA=WRITE.ALL; VAR PPM; WITH WTABZ;
PROC CORR DATA=WRITE.ALL; VAR PPM; WITH WTCUGL;
PROC CORR DATA=WRITE.ALL; VAR PPM; WITH WTAC;
PROC CORR DATA=WRITE.ALL; VAR PPM; WITH WTACBZ;
PROC CORR DATA=WRITE.ALL; VAR PPM; WITH CTPPM;
PROC CORR DATA=WRITE.ALL; VAR PPM; WITH CZPPM;
PROC REG; MODEL PPM=PLT;
/*
```

APPENDIX 4.3

SASRUN 3

```
//WENHI012 JOB (0,K348CH),'DUNOVANT SASRUN3',
// TIME=(0,30),REGION=256K
/*ROUTE PRINT RMT3
// EXEC SAS796
//WRITE DD UNIT=3380,VOL=SER=M80115,
// DSN=WENHI01.SASRUN1,DISP=OLD,SPACE=(TRK,(5,5),RLSE)
//SAS.SYSIN DD *
DATA ONE;SET WRITE.ALL;
PROC ANOVA DATA=WRITE.ALL; CLASS PLT; MODEL PPM=PLT;
PROC GLM DATA=WRITE.ALL; CLASS PLT;MODEL PPM=PLT;
  LSMEANS PLT/E STDERR PDIFF;
PROC SORT DATA=WRITE.ALL; BY PLT;
PROC CORR DATA=WRITE.ALL;BY PLT;VAR PPM; WITH DAY--HUM;
PROC PLOT DATA=WRITE.ALL;BY PLT;PLOT PPM*(DAY--HUM);
PROC CORR DATA=WRITE.ALL NOMISS;BY PLT;VAR PPM;WITH WMEK--CZMGM;
PROC PLOT DATA=WRITE.ALL;BY PLT;PLOT PPM*(WMEK--CZMGM);
PROC GLM DATA=WRITE.ALL;CLASS PLT;
  MODEL PPM=PLT FLO PLT*FLO;
PROC GLM DATA=WRITE.ALL;CLASS PLT;
  MODEL PPM=PLT FLO;
/*
```

APPENDIX 4.4

SASRUN 4

```
//WENHI014 JOB (0,K348CH),'DUNOVANT SASRUN4',
// TIME=(0,30),REGION=1024K
/*ROUTE PRINT RMT3
// EXEC SAS79S
//WRITE DD UNIT=3380,VOL=SER=MEO116,
// DSN=WENHI01.SASRUN1,DISP=OLD,SPACE=(TRK,(5,5),RLSE)
//SAS.SYSIN DD *
DATA ONE;SET WRITE.ALL;
PROC SORT DATA=WRITE.ALL;BY PLT;
PROC GLM; CLASS PLT;
MODEL PPM=PLT FLO PLT*FLO;
PROC GLM;CLASS PLT;MODEL PPM=PLT FLO;
PROC CORR;BY PLT; VAR PPM;WITH WEEK--CZMGM;
PROC REG;BY PLT;MODEL PPM=PLT;OUTPUT OUT=BOTH1 P=PRPPM;
PROC PLOT DATA=BOTH1;PLOT PPM*PLT PRPPM*PLT='*'/OVERLAY;
TITLE PREDICTED VS. ACTUAL PPM;
PROC REG;BY PLT;MODEL CTPPM=PPM;OUTPUT OUT=BOTH2 P=PRCTPPM;
PROC PLOT DATA=BOTH2;PLOT CTPPM*PPM PRCTPPM*PPM='*'/OVERLAY;
TITLE PREDICTED VS. ACTUAL CTPPM;
PROC REG;BY PLT; MODEL CZPPM=PPM; OUTPUT OUT=BOTH3 P=PRCZPPM;
PROC PLOT DATA=BOTH3;PLOT CZPPM*PPM PRCZPPM*PPM='*'/OVERLAY;
TITLE PREDICTED VS. ACTUAL CZPPM;
PROC REG;BY PLT; MODEL WTAC=PPM;OUTPUT OUT=BOTH4 P=PRWTAC;
PROC PLOT DATA=BOTH4;PLOT WTAC*PPM PRWTAC*PPM='*'/OVERLAY;
TITLE PREDICTED VS. ACTUAL WTAC;
PROC REG;BY PLT;MODEL WTAUGL=PPM;OUTPUT OUT=BOTH5 P=PRWTAUGL;
PROC PLOT DATA=BOTH5;PLOT WTAUGL*PPM PRWTAUGL*PPM='*'/OVERLAY;
TITLE PREDICTED VS. ACTUAL WTAUGL;
PROC REG;BY PLT;MODEL WZAUGL=PPM;OUTPUT OUT=BOTH6 P=PRWZAUGL;
PROC PLOT DATA=BOTH6;PLOT WZAUGL*PPM PRWZAUGL*PPM='*'/OVERLAY;
TITLE PREDICTED VS. ACTUAL WZAUGL;
PROC REG;BY PLT;MODEL WTABZ=PPM;OUTPUT OUT=BOTH7 P=PRWTABZ;
PROC PLOT DATA=BOTH7;PLOT WTABZ*PPM PRWTABZ*PPM='*'/OVERLAY;
TITLE PREDICTED VS. ACTUAL WTABZ;
PROC REG;BY PLT;MODEL WTCUGL=PPM;OUTPUT OUT=BOTH8 P=PRWTCUGL;
PROC PLOT DATA=BOTH8;PLOT WTCUGL*PPM PRWTCUGL*PPM='*'/OVERLAY;
TITLE PREDICTED VS. ACTUAL WTCUGL;
PROC REG;BY PLT;MODEL WTACBZ=PPM;OUTPUT OUT=BOTH9 P=PRWTACBZ;
PROC PLOT DATA=BOTH9;PLOT WTACBZ*PPM PRWTACBZ*PPM='*'/OVERLAY;
TITLE PREDICTED VS. ACTUAL WTACBZ;
PROC REG;BY PLT;MODEL WTACBZ=CTPPM;OUTPUT OUT=BOTHA P=PRWTACBZ;
PROC PLOT DATA=BOTHA;PLOT WTACBZ*CTPPM PRWTACBZ*CTPPM='*'/OVERLAY;
TITLE PREDICTED VS. ACTUAL WTACBZ;
/*
```

APPENDIX 4.6

SASRUN 6

```
//WENHI016 JOB (0,K348CH),'DUNOVANT SASRUN6',
// TIME=(0,30),REGION=1024K
/*ROUTE PRINT RMT3
// EXEC SAS79S
//WRITE DD UNIT=3380,VOL=SER=M80116,
// DSN=WENHI01.SASRUN1,DISP=OLD,SPACE=(TRK,(5,5),RLSE)
//SAS.SYSIN DD *
DATA ONE;SET WRITE.ALL;
IF PLT=1 THEN DO;
FLO1=FLO;PPM1=PPM;END;
IF PLT=2 THEN DO;
FLO2=FLO;PPM2=PPM;END;
IF PLT=3 THEN DO;
FLO3=FLO;PPM3=PPM;END;
PROC PLOT;PLOT PPM1*FLO1='A' PPM2*FLO2='B' PPM3*FLO3='C'/
OVERLAY;
PROC CORR;BY PLT;VAR DAY--CZMGM;
/*
```

APPENDIX 4.7

SASRUN 7

```
//WENHI017 JOB (0,K348CH),'DUNOVANT SASRUN7',
// TIME=(0,30),REGION=1024K
/*ROUTE PRINT RMT3
// EXEC SAS796
//WRITE DD UNIT=3380,VOL=SER=M80116,
// DSN=WENHI01.SASRUN1,DISP=OLD,SPACE=(TRK,(5,5),RLSE)
//SAS.SYSIN DD *
DATA ONE;SET WRITE.ALL;
PROC CORR PEARSON SPEARMAN KENDALL;BY PLT;
VAR DAY--HUM;
PROC CORR PEARSON SPEARMAN KENDALL;BY PLT;
VAR DAY TIME PPM WMEK--CZMGM;
/*
```

APPENDIX 4.8
SASRUN 8

```
//WENHI018 JOB (0,K348CH),'DUNOVANT SASRUN8',
// TIME=(0,30),REGION=1024K
/*ROUTE PRINT RMT41
// EXEC SAS79S
//WRITE DD UNIT=3350,VOL=SER=M80116,
// DSN=WENHI01.SASRUN1,DISP=OLD,SPACE=(TRK,(5,5),RLSE)
//SAS.SYSIN DD *
DATA ONE;SET WRITE.ALL;
PROC NPAR1WAY;CLASS PLT;VAR CTPPM CZPPM CTOL CTCE CMIBK CBENZ;
DATA TWO; SET WRITE.ALL;
IF 0900 LE TIME LE 1200 THEN AMPM=1;
IF 1201 LE TIME LE 1500 THEN AMPM=2;
IF 1501 LE TIME LE 1800 THEN AMPM=3;
IF 1801 LE TIME LE 2100 THEN AMPM=4;
PROC GLM;CLASS PLT AMPM DAY;
MODEL PPM=AMPM PLT DAY;
DATA THREE; SET WRITE.ALL;
IF 2 LE DAY LE 4 THEN DD=1;
IF DAY=1 THEN DD=2;
IF DAY=5 THEN DD=2;
IF 6 LE DAY LE 7 THEN DD=3;
PROC GLM;CLASS DD PLT DAY;
MODEL PPM=DD PLT DAY;
DATA FOUR; SET WRITE.ALL;
PROC PLOT;BY PLT;
PLOT PPM*CTOL;
PROC PLOT; BY PLT;
PLOT PPM*CTPPM;
PROC PLOT; BY PLT;
PLOT PPM*CZPPM;
PROC PLOT; BY PLT;
PLOT PPM*CMIBK;
PROC PLOT; BY PLT;
PLOT PPM*CCLBZ;
PROC PLOT; BY PLT;
PLOT PPM*CPCE;
PROC PLOT; BY PLT;
PLOT CTOL*WTOL;
PROC PLOT; BY PLT;
PLOT CTPPM*WTAC;
PROC PLOT; BY PLT;
PLOT CBENZ*WBENZ;
PROC PLOT; BY PLT;
PLOT CTCE*WTCE;
PROC PLOT; BY PLT;
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APPENDIX 5

DETERMINATION OF A STATISTICAL MODEL FOR THE CENTURY OVA DATA

APPENDIX 5.1

DETERMINATION OF A PROPER STATISTICAL MODEL

Model No.	Model	Degrees of Freedom	Likelihood-Ratio Chi Square	Probability
1	Plant	15	210.21	0.0
2	Time	16	221.00	0.0
3.	Peak	15	87.92	0.0000
4.	Plant, Time	14	208.70	0.0
5.	Time, Peak	14	86.41	0.0000
6.	Plant, Peak	13	75.62	0.0000
7.	Plant, Time, Peak	12	74.11	0.0000
8.	Plant-Time	12	206.93	0.0
9.	Plant-Peak	9	20.53	0.0149
10.	Time-Peak	12	71.71	0.0000
11.	Plant, Time-Peak	10	59.41	0.0000
12.	Time, Plant-Peak	8	19.02	0.0147
13.	Peak, Plant-Time	10	72.34	0.0000
14.	Plant-Time, Plant-Peak	6	17.25	0.0084
15.	Plant-Peak, Time-Peak	6	4.32	0.6330
16.	Time-Peak, Plant-Time	8	57.64	0.0000
17.	Plant-Time, Plant-Peak, Time-Peak	4	3.46	0.4838

APPENDIX 5.2

The goal of this statistical program is to find a model that fits well (i.e., small Chi Square), with as few terms as possible. The best fitting model is as follows:

$$\log P_{\text{Plant-Time-Peak}} = U_{\text{Plant}} + U_{\text{Time}} + U_{\text{Peak}} + U_{\text{Plant Time}} + U_{\text{Plant Peak}} + U_{\text{Time Peak}}$$

This model has a Chi Square (X^2) of 3.46 with 4 degrees of freedom which yields a P <0.005.

If the plant-peak term is eliminated, there are only 4 degrees of freedom with a X^2 diff = 54.18 as follows:

(17)-(16) = X^2 diff = 57.64 - 3.46 = 54.18; df = 4

Therefore, the plant-peak term must be retained since P <0.005.

If the plant-time term is eliminated the result is as follows:

(17)-(15) = X^2 diff = 4.32 - 3.46 = 0.86; df = 2

This X^2 diff is not significant and the plant-time peak can be eliminated. This yields the following model:

$$\log P_{\text{Plant-Time-Peak}} = U_{\text{Plant}} + U_{\text{Time}} + U_{\text{Peak}} + U_{\text{Plant-Peak}} + U_{\text{Time Peak}}$$

The X^2 for this model alone is also very small which indicates a good fitting model.

This simplified model indicates that all first order interactions between plant, time and peak must be considered except the interaction of plant with time.

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